The Journal

of the

Astronomical Society of India.

EDITED BY C. T. LETTON, ESQ.

VOL. I.

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The Journal
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Vol. I.] SESSION 1910-1911. [No. 1.

Origin of the Society.

A proposal was made in the middle of the month of July 1910, by a few gentlemen in Calcutta, to form an Astronomical Society in India. The idea arose from the interest which had recently been taken in the appearance of Halley's Comet, and it was felt that, given the chance, there were probably many in India who would join a Society of the kind. A Meeting was therefore called on the 26th July 1910 at which the matter might be discussed. A room in the Imperial Secretariat was kindly placed at their disposal by the Comptroller-General. The attendance at this Meeting was large, and Mr. H. G. Tomkins, F.R.A.S., having been voted to the Chair, explained what it was proposed to do, and showed how astronomical work could be undertaken by amateurs in India at trifling cost if they combined together in their work. The work of similar Societies in England and other countries was also referred to, and it was pointed out how a similar Society in India could do good work. After some discussion, it was unanimously resolved to form an Astronomical Society in India, and fifty-seven gentlemen promised their support on the spot. A Preliminary Committee was then elected with instructions to draw up rules and take other measures at once to carry out the decision of the Meeting. A second Meeting was called for the 26th August 1910. In the meantime the Preliminary Committee sat twice a week and drew up a code of Bye-laws. They also advertised the fact of the formation of the Society and made other arrangements for putting it on a proper footing.

The first measure of the August Meeting was to name the Society, and it was unanimously decided to call it "The Astronomical Society of India." Those original members who had joined and were present then formally signed the roll of the Society. With a few modifications the Bye-laws as drawn up by the Preliminary Committee were passed, and the subscription was fixed at eight rupees a year and an entrance donation of four rupees. It was decided that those who joined by the end of September should be original members free from entrance donation, and that the first Session of the Society should begin on the 1st October 1910. The Preliminary Committee were requested to propose a Council for election during the next month, and special provision was made to enable this Council to be elected by the time of the next Meeting on the 27th September 1910. The membership at the Meeting of the 26th August stood at one hundred and seventeen. It was decided to register the Society.

During September a Council was elected and sections formed. To start with, these were limited to a variable Star Section, Meteors, the Moon and a General Section comprising solar work, Comets, the Milky Way, and work not dealt with by the other sections. Major Lenox Conyngham, R.E., F.R.A.S., Mr. Rakshit, The Revd. J. Mitchell, M.A., F.R.A.S., and Dr. E. P. Harrison were appointed as Directors of these sections, and requested to consider programmes of work for those who joined them. Mr. R. J. Watson was also appointed as Director of Photography.

The Director of the Kodai Kanal Observatory was written to, and he promised his support to the Society, beside himself joining it.

The question of a library was taken up; a librarian, Mr. A. Lawrie, was appointed, and some donations for the purpose having been received, a consignment of books was ordered from England.

Communications having been received from a number of members asking when they could obtain instruments, several firms in England were written to on the subject with a view to facilitating the acquisition of these in India. The third Meeting before the commencement of the Session was held on the 27th September 1910, and the minutes of the previous Meeting having been passed, the Chairman stated that the Preliminary Committee had finished the business for which it had been appointed and would retire on the 30th September. The result of the election of the Council was then announced by the scrutineers and a vote of thanks was passed to the retiring Committee. In acknowledging the honour the Society had done him in electing him as their

first President, Mr. Tomkins asked, on behalf both of himself and the Council, in which he specially included the Directors of Sections, for the active support of the members, pointing out that, without such support, it would be impossible for the most energetic Council to make the Society all that it should be, and that the measure of success attained must of necessity be what the members themselves made it. If observations were to be published, they must first be made; and if work was to be discussed at Meetings and in the Journals, it must first be done. In the same proportion therefore as members were themselves active, would the Meetings and Journals be interesting and valuable. He therefore asked members to very carefully consider the proposals which the Directors of Sections were about to put before them, and then to decide on a line of action and take it up energetically.

The membership of the Society was announced to have reached the satisfactory total of 184, and those members present who had not already done so signed the roll.

The President then called upon the Director of each Section in turn to set before the Meeting the outline of work which they had prepared, as well as the instructions which they proposed to issue, to enable the observations required to be made. This was done with the aid of magic lantern slides.

The Meeting then adjourned until the 25th October 1910.

Report of the Meeting of the Society held on Tuesday the 26th October 1910.

H. G. TOMKINS, F.R.A.S., *President*, in the Chair.
W. G. BURN, B.SC., *Secretary*.

Mr. Burn read the minutes of the previous meeting, which were confirmed.

The President then announced that Mr. Michie Smith, Director of the Kodai Kanal Observatory, had accepted the appointment of Vice-President of the Society, and that Dr. Gilbert Walker, Director General of Observatories in India, who had joined the Society as an original member, had been elected as Vice-President by the Council to fill one of the two vacancies still on the Council. This election was confirmed with applause.

It was then announced that the Council, in view of the large number of enquiries which were being received regarding the purchase of instruments and requests for advice concerning them, had, under Bye-law 4 of the Society, appointed an Instrumental Director in whose hands this work could be placed. The appointment would be continued as long as the need for it existed, and Mr. S. Woodhouse, Manager of the Mathematical Instrument Department of the Government of India, had very kindly consented to fill the post. The appointment was confirmed.

As Mr. P. C. Bose, elected Treasurer, was unable to take up the duties, Mr. U. L. Banerjee, proposed by the Council, continued as Treasurer. Mr. Banerjee then read the balance sheet of the Society, showing a balance of cash in hand amounting to Rs. 256-10-3.

The President stated that Mr. Woodhouse had, at the cost of considerable labour, prepared for the Society a set of Star Charts, a copy of which would shortly issue free to each member. The thanks of the Meeting were unanimously accorded to Mr. Woodhouse for this valuable piece of work.

Mr. Rakshit, Director of the Meteor Section, read a short paper on the position of the constellation Leo in November, and of the radiant point of the Leonid Meteor showers which, though it had fallen off in recent years, should nevertheless be looked for on the nights of the 13th to 16th November. He explained his note with the aid of a neat diagram, and hoped that he would receive observations in time for use at the November Meeting.

Mr. Colquhoun then read a paper on an instrument which he had constructed to enable one to find the position of the

Sun with relation to the observer at any time of year and at any hour of the day. He exhibited the instrument and explained how it was worked.

Mr. Urquhart—Can the instrument be used in a room ?

Mr. Colquhoun—Certainly. It is only necessary to set it in the room with the aid of a compass.

The President remarked that the instrument, which was very ingenious, was a reversal of the principle of the sun-dial. The ordinary use of the sundial was from the position of the Sun to tell the time. Mr. Colquhoun had reversed the arrangement and given the time and date; his pointer indicated the position of the Sun. The thanks of the Meeting were then accorded to Mr. Colquhoun for his paper and the trouble he had taken to bring the instrument to the Meeting and explain it.

Mr. Tomkins showed some magic lantern slides of Halley's Comet, taken at the Kodai Kanal Observatory, which had been very kindly sent by Mr. Michie Smith, together with the bulletin of the Observatory relating to the Comet. The slides taken on the small scale showed an extremely interesting amount of detail in the tail of the Comet. Those taken with the 9½ inch reflector were greatly admired, the detail brought out in the pictures being marvellous.

The Secretary then read a short paper from Mrs. Percy Brown describing the Comet as seen from Java, and an extract was also given of a communication from Mr. Durham of Bombay describing the Comet as seen from Harda on the 4th May 1910. Mr. Durham thought that the tail of the Comet fanned out like the tail of a peacock and estimated it to have been of great length.

Mr. Mears remarked that he could not agree with Mr. Durham that the tail fanned out. According to his observations the tail was singularly straight and of uniform width the whole way down. That was remarkable, because it was not what would be expected, and would seem to indicate that there was very great difference in the distance from the earth to the various portions of the tail.

The President—I can bear out Mr. Mears' observation. To me the tail certainly did not appear to fan out either before or after the transit. Of course there are details on the photographs that were not visible to the eye, but I take it Mr. Mears is referring to the tail as visible to the naked eye.

Mr. Mears—Yes. I refer of course to the appearance to the eye.

Mr. Simmons said that on one morning he had noticed three exceedingly bright meteors which proceeded from the

Constellation Aquarius. He thought the shower was active about that time, and wondered if there were any connection between it and the Comet.

The thanks of the Meeting were then unanimously accorded to Mr. Michie Smith for sending the photographs and to the writers of the papers.

Mr. Tomkins then read a short note on the observations which could be made at the total eclipse of the Moon which is to take place on the morning of the 17th November, explaining the phases of the eclipse by means of a diagram. Attention was directed to the behaviour of any stars that might be occulted, the appearance of the bright rays of Copernicus, Tycho and Proclus as the shadow passed over them, and also in the shadow, the presence of any abnormally bright or dark spots in the shadow, the detailed observation of one or two rays selected by the observer, the colour of the eclipse, and the regularity or otherwise of the shadow.

The Meeting was then adjourned until the 29th November 1910 at 5 p.m.

Meteors.

By the Director of the Section.

The phenomena of this branch of Astronomy are most interesting and by no means unimportant. They may be conveniently divided into three classes: *namely*, (1) Aerolites, (2) Fireballs, (3) Shooting Stars. Of these three classes, aërolites, meteorites or meteoric stones, are rare, but not so rare as to prevent sufficient evidence being produced that such occurrences happened from time to time. Indeed there are observations from which we can legitimately conclude that from time to time masses of stone of different sizes and generally of considerable weight passed through space and were precipitated upon the Earth's surface. The circumstances attending the fall of aerolites are not always the same. Generally the fall is attended by a loud detonation; but it must not be concluded that every detonating meteor is an aërolite.

Now we come to the second class, *namely*, Fireballs. They are occasionally of great brilliancy, appear suddenly, and are usually noiseless. Their form is generally pear-shaped. The slow moving Fireballs generally evolve trains of sparks, but the swifter class project streaks of phosphorescence upon the sky, and these features sometimes linger for many minutes after the first appearance. Many Fireballs have formed the subjects of computation as to their distances, sizes and velocities, but the peculiar nature of these phenomena and their unexpected appearance lead

us to consider such results as only approximate. It has been found that the average heights of Fireballs are less than those of Shooting Stars, and from some recorded cases, it appears that the relative results seem to be somewhat as follows :—The heights of Fireballs at first appearance, at mid-course and at disappearance, were 69, 49½ and 30 miles; whereas those of Shooting Stars were 80, 67 and 54 miles respectively. It may not be out of place to say here that the same method of observations will apply both to Fireballs and Shooting Stars, and that there are certain Meteor showers which apparently yield a large proportion of Fireballs.

Now we come to the third class, *i.e.*, that of Shooting Stars. Formerly Shooting Stars were considered to have an atmospheric origin and to be due to the combustion of inflammable gases exhaled by the earth. But now this theory has been rejected. They are now considered to be of celestial origin, pursuing orbits similar to comets and grouped into streams containing in many cases an immense assemblage of particles. They become visible to us on being inflamed by friction with our atmosphere, into which they rush with planetary velocity and are instantly consumed and reduced to imperceptible dust. Every clear night a certain number of Shooting Stars are visible. When the air is transparent, the moon absent, and the stars shine brightly, about 8 or 10 may be noticed every hour. The hourly average is greater in the morning hours and during the last half of the year. On some nights we may see a shower of falling stars, and the shower in certain years is very dense. It is held that these little bodies are not scattered uniformly in space, but are collected into distinct groups which travel, as comets travel, in elliptical orbits round the Sun, and what we call a shower of meteors is due to the earth breaking through one of these groups. Two of the important showers are encountered in August and November. They are respectively Perseids and Leonids. I would refer those interested in the history of these showers to the work of Mr. Denning of Bristol. The Shooting Stars in a particular shower seem to radiate from a particular point in space, *i.e.*, if their directions of motion are all projected backwards they intersect in one region, and this is the radiant point of the shower. Eighty-eight radiant points are mentioned of the principal meteoric showers of the present year, and of these nine are important.

For the observation of direction a Star Chart is essential, and the observer must know at least the constellations in which the radiant point of the shower he is observing is situated. The method of observation is to have a straight rod in the hand, and when a meteor is seen, to hold it against the sky along the path where the meteor has appeared. This

will then give a good indication of the stars near which the tract is to be charted, and when these have been thus determined, the path can be recorded in the chart or note-book. For this the chart will have to be lighted in such a manner that the light may not blind the eyes, and a bicycle lamp with a shade will be found useful. For the other details, such as magnitude, colour, etc., I suggest a regular form such as the following:—

*Name of Observer*_____________*Place*___________.

Date.	State of the sky.	TIME.		No. of Meteor.	Colour.	Whether it left a tail or not.	Swift or slow.	REMARKS.
		H.	M.					
				1 2 3 4 etc.				

The radiant points of these are in the constellations Quadrans, Lyra, Aquarius, Perseus, Orion, Leo, Andromeda and Gemini.

The remaining four important showers of the present year are Orionids of 18th to 20th October, Leonids of 14th to 16th November, Andromids of 17th to 23rd November, and Geminids of 10th to 12th December. The first, *i.e.*, Orionids: it is a rich shower occurring every year. The R. A. and Dec. of the radiant point are 92° and + 15°, *i.e.*, 2° east of Orionids. The meteors are swift with streaks. The second, *i.e.*, Leonids: it has the radiant point with R. A. 150° and Dec. + 22°. The meteors are swift with streaks. The third, *i.e.*, Andromids: it has the radiant point with R. A. 25° and Dec. + 43°: the meteors are very slow with trains. The fourth, *i.e.*, Geminids: it has the radiant point with R. A. 108° and Dec. + 33°. It is a rich annual shower of swift short meteors.

Lastly, we have to consider what observations are to be made in connection with meteors. In the first place we may simply count the number of meteors that are visible, noting the time during which they were watched. This will give us the relative frequency during different parts of the night and during different parts of the year. But not less important are the observations of the directions of motion, the duration of visibility, the magnitude and the colour of the meteor, together with any peculiarity that may be noticed in connection with it.

Outline of Work for the Lunar Section.

BY THE DIRECTOR OF THE SECTION.

The advice given in the following notes is offered to beginners only, but if the old lunar hands, in addition to their own special work, will co-operate with the Section in that particular field now suggested, it will greatly enhance the value of the work which the Section may do as a whole.

Telescope—

From 3″ upwards.

Books—

1. Proctor's Moon. A general book.
2. Elger's Moon (George Philip & Son). A thoroughly practical book. All members of the Section should procure this work.

Map—

Elger's Map. The map in the book, in four Sections, may be taken out and bound separately.

METHODS OF WORK.

I. General Instructions—

1. Make careful notes.
2. Sketch precisely what is seen. No more, no less.
3. Never alter the notes or the sketch.
4. Do not trouble too much about the work that has been done in the same field. Be original.
5. Let there be uniformity in the size of the Drawings.
6. Make fresh sketches each night if possible.
7. Follow up the work through several lunations.

II. More Specific Instructions—

In connection with all sketches and observations—

1. Note aperture of Telescope and power used.
2. Note character of Atmosphere—moist, clear, cloudy, unsteady, etc.
3. Note age of Moon and date.
4. Note position of terminator.

Special fields of Study—

1. A Ray Centre *Proclus.*
2. A Sea (Mare) *Mare Serenitatis.*
3. A Walled Plain *Schickard.*
4. A Catalogue of Bright Spots.

I. Proclus—

Concentrate on this particular Ray centre. How do the Rays behave under varying altitudes of the Sun?

Special features.—Do the Rays get wider, narrower, or longer. Do they change their positions, or do they change in brightness at all from one lunation to another?

II. Mare Serenitatis—

Sketch and describe appearance under varying altitudes of Sun through several lunations.

Special features—

1. Study the dark stain round the margin of the southern portion. Does it vary in any way?
2. Note if there are any 'ripple' marks along the edge of the terminator.
3. Examine the strange 'parallel structure' South of the sea.

III. Schickard—A typical walled plain.

Study carefully the walls and floor through several lunations.

Special features—

Note the peculiar shading in North and South portions of floor. Is this shading constant?

IV. Bright Spots—

There is so far no complete catalogue of these bright spots. It is proposed to chart them.

Scale.—

Elger's Map.

h. m. h. m.
22nd April 1910, 4-44 to 5-17 St. Time.

h. m. h. m.
3rd May 1910, 4-32 to 5-10 St. Time.

Halley's Comet taken at the Kodai Kanal Observatory
reproduced by kind permission of the Director.

Papers communicated to the Society.

Observation of Halley's Comet in Java.

May 18th, 1910.

By Mrs. Percy Brown.

As far as our view of Halley's Comet last May could be of any astronomical value, I fear the results would be useless, though the wonderful beauty and magnitude of the sight, seen as it was under peculiarly picturesque circumstances, is never to be forgotten, and has excited a deep interest in the subject.

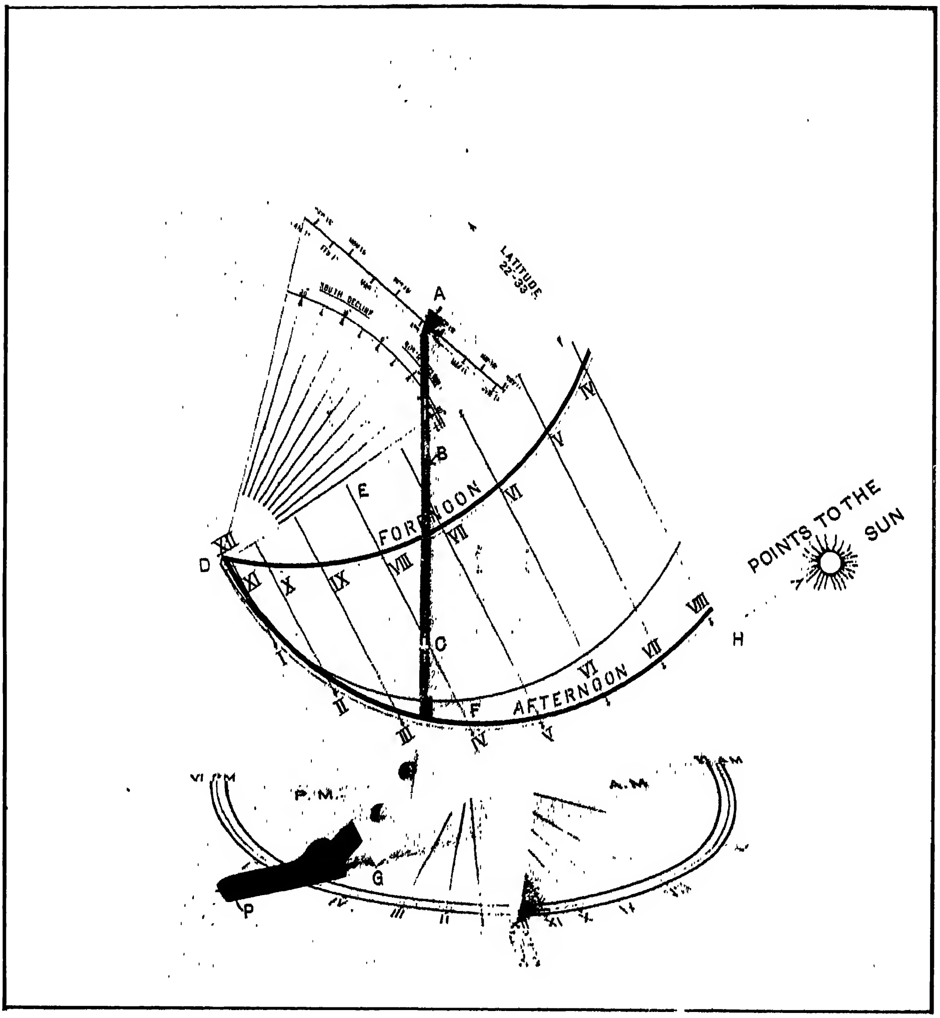
We were fortunate in staying at the time in the interior of Java (where the atmosphere is distinctly clearer than in India), near an ancient Buddhist Stupa called "Borobodoer" or place of innumerable Buddhas, and a feeling of almost superstitious awe crept over one when one thought of those age-long sculptured figures seated in mystic meditation night after night, for centuries gazing across the heavens, and how many times they must have witnessed the re-appearance of this very same heavenly visitant, as each successive century it must have swept over their heads in its eternal journeyings. I awoke almost instinctively at about 3 a.m. on the 18th of May, and, looking out of my window, I saw a mysterious gleam in the dark sky over the black tree-tops, and calling my husband we got up and went to the Stupa, where we saw the vast tail of the Comet stretching from the horizon right to the zenith—the gleam I had seen over the trees developing into the most marvellous shaft of clear shining white light, almost like a miraculous search-light sent across the heavens. The head of the Comet was hidden from our view by the outline of a far-distant volcano, whose jagged and smoking silhouette was brought into clear prominence against the shining marvellous background, and accentuated the awe of the scene, as that volcano was not to be seen in the day-time, owing to the morning clouds which almost invariably shrouded it.

On other evenings we saw the vanishing Comet, strangely diminished, with its tail still pointing upwards, and the extraordinary difference in size made one realize the velocity with which it must be travelling through space, and as it gradually grew fainter and more misty, a feeling of sadness came over one that it had vanished from *our* ken for ever, for it made one realize how inevitable the words "*for ever*" can be; but though we shall not see Halley's Comet again, the watching Buddhas on Borobodoer will.

Note on the Leonid Meteor Shower.

By B. M. Rakshit, Esq.

At the last meeting of this Society, attention was drawn to the fact that to observe the paths of Meteors in a shower, it is essentially necessary for the observer to get himself thoroughly acquainted with the constellation in which the radiant point of the shower to be observed is situated. The next important shower being the Leonids of 14th to 16th November, it may be useful to give a short description of the constellation Leo—the Lion. A straight line from the Pole Star κ Ursæ Minoris passing through the Pointers, *i.e.*, κ Ursæ Majoris and β Ursæ Majoris will bring us to the middle of the constellation Leo. The brightest star in it is called Regulus, the magnitude of which is 1·3 and the R. A. and declination are 10 hrs. 4 mts. and 12°-24′ N. This star, with five or six smaller ones, forms a sickle or reaping hook, Regulus being the handle. On the 14th of November it will rise at Calcutta at 12 hrs. 9 mts. astronomical time, which corresponds to common time 0 hr. 9 mts. a.m. of the 15th November. Its amplitude at that time will be 13° 27′, *i.e.*, this will be its angular distance from the East point towards North. The star next above it is a small one, and the one above this is γ Leonis, the magnitude of which is 2·5 and the R.A. and the declination are 10 hrs. 15 mts. and 20°-17′ N. Higher up is a small star, and then we come to the star which forms an eye of the Lion. It is a star of the third magnitude and is called ϵ Leonis. The R. A. and declinations are 9 hrs. 41 mts. and 24°-11′ N. Passing these we come to another series consisting of four stars and having right ascensions a few minutes more than 11 hrs. The lowest two of these are small ones. The third is called θ Leonis, the magnitude of which is 3·4. The highest of these four is Leonis, whose magnitude is 2·6 and the R. A. and the declination are 11 hrs. 9 mts. and 21°-1′ N. Lastly, at the end of the tail of the Lion we have the bright star called Denebola or β Leonis. This is the second star in order of magnitude in this constellation. Its R. A. and declination are 11 hrs. 44 mts. and 15°-4′ N. The R. A. and the declination of the radiant point of the shower Leonid are 10 hrs. 0 mts. and 22°-0′ N. On the 14th of November this point will rise at Calcutta at 11 hrs. 47 mts. p.m. Calcutta time, and its angular distance at that time from the East point will be 23°-56′ towards North. It will cross the meridian of Calcutta at 18 hrs. 27 mts. astronomical time, which corresponds to 6 hrs. 27 mts. a.m. of the 15th. But the Sun will rise before this time, the time of sunrise being 6 hrs. 14 mts. a.m.


LATITUDE 22°33'
SOUTH DECLINE
A
B
C
D
E
F
G
H
P
FORENOON
AFTERNOON
POINTS TO THE SUN
VI P.M.
P.M.
A.M.
VI A.M.

A simple apparatus for finding the position of the Sun in the heavens at any time of the year.

By J. A. Colquhoun.

The apparatus consists of two parts—an ordinary horizontal sundial and a vertical sundial—capable of rotary movement in a vertical plane, and resting on a small horizontal heel plane shewn at P in the illustration.

The working of this apparatus is based on the fact that the Sun must lie in the altitude angle line G H when the vertical dial is revolved on P, so that the line G H lies in the time indicating the plane of the Sun's rays cast on the horizontal dial. For example :—

To find the position of the Sun in the heavens on, say, the 3rd April at 4 p.m., set the pointer of the sliding piece A of the swinging plumbob bar B to the 3rd April on the vertical dial.

Set the index pointer C at the end of B to the 12 o'clock point D.

Tilt the vertical plane of the dial until C lies on the 4 o'clock line E F.

The bottom line G H of the dial will now be at an angle with the horizon, equal to the Sun's altitude angle. Now place this vertical dial on the horizontal dial, so that the lower end point of the altitude line at G rests exactly on the 4 p.m. line at a convenient point. Now horizontally revolve the vertical dial about the point G until the bottom line G H touches the upper edge of the gnomon. The line G H now points to the Sun's place in the heavens on the 3rd April at 4 p.m.

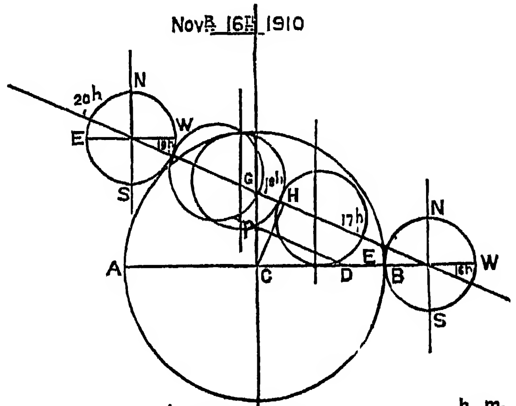
Care must be taken that the gnomon is set vertically in the meridian of the place of observation, in this case Calcutta.

Details of both types of dials are given in the Encyclopædia Britannica under "Dialling."

The vertical type is attributed to the Jesuit Father De Saint Regaud.

Note on the Total Eclipse of the Moon, November 16th, 1910.

The following diagram is a graphical presentation of the Eclipse of the Moon which is to take place on the 16th November 1910. It is drawn on the plan given in Loomis' Astronomy, the large circle representing the shadow of the earth, and the smaller circles the moon in its progress along its path through the shadow. The hours from 16 to 20 are marked along the path so as to indicate the position of the moon's centre at those times.



	h. m.		h. m.
First cont. Pen	15-15-6.	End totality	16-16-8.
" " Shadow	16-14-1.	Last cont. shadow	19-27-7.
Beginning totality	17-25-0.	" " Pen:	20-26-2.
Middle "	17-50-9.	Astronomical Time.	

As the moon will set at about 18 hours, the last part of the eclipse will not be visible in India.

I may perhaps remind members that the 16th November, at 16 hours Astronomical time, corresponds to 4 o'clock in the morning of the 17th November.

Memoranda for Observers.

Standard Time is adopted in these Memoranda.

Sidereal Time at 8 p.m.

	H.	M.	S.
November 1st	22	39	59
8th	23	7	35
15th	23	35	11
22nd	0	2	47
29th	0	30	23

From this table the constellations visible during the evenings of November can be ascertained by a reference to their position as given in a Star Atlas.

Moon.

		H.	M.
November 2nd . .	New Moon	7	26 a.m.
10th . .	First Quarter	10	59 a.m.
17th . .	Full Moon	5	55 a.m.
23rd . .	Last Quarter	11	43 p.m.

A total eclipse of the Moon will occur on the early morning of the 17th November 1910.

First contact with the Penembra .	3	15·6 a.m.
First contact with the Shadow .	4	14·1 a.m.
Beginning of Total Phase . .	5	25·0 a.m.
Middle of Eclipse	5	50·9 a.m.
End of Total Phase	6	16·8 a.m.
Last contact with the Shadow .	7	27·7 a.m.
Last contact with the Penembra .	8	26·2 a.m.

Moon sets about 6-15 a.m.

Magnitude of the Eclipse (Moon's diameter =1) 1·131.

The first contact with the Shadow occurs at 94° from the North point of the Moon's limb towards East.

Meteors.

There are two important showers in November—the Leonids and the Andromids.

	Date.	Radiant point.	Character.
	Nov.	R.A. Dec.	
Leonids .	14th 16th	150 + 22	Swift streaks.
Andromids .	17th 23rd	25 + 43	Very slow trains.

Moonlight may interfere with the observation of these showers, especially the former. Other showers occur on November 1st, 2nd, 10-12th, 16-28th, and 20-23rd.

Planets.

Saturn will be visible practically all night.

		H.	M.	S.		
November 15th ...	R.A.	2	1	39	Dec. N.	9° 29′ 17″

Venus will be in conjunction with the Sun on the 26th November, after which it will become an evening star.

Mars and Jupiter are early morning stars, rising between 4 and 5 a.m.

Notices of the Society.

The work of the Council having been distributed among its officers, it is particularly requested that regard may be had to the following in addressing communications :—

	Should be addressed to—
(1) Subscriptions, donations and other communications relating to the receipt or payment of money. Cheques and money orders should also be made payable to this officer.	The Treasurer, U. L. BANERJEE, ESQ., M.A. Office of the Acctt. General, Bengal, Calcutta.
(2) Papers and other communications to be read at the Meetings as well as communications or suggestions relating to the Scientific work of the Society.	The Secretary, W. G. BURN, ESQ., B.Sc.
(3) Books and all communications connected with the library.	The Librarian, A. LAWRIE, ESQ., 81, Middle Road, Barrackpore.
(4) Communications other than those at (2) above intended to be printed, and all communications connected with the Journal.	The Editor, J. J. MEIKLE, ESQ., 8, Hastings Street, Calcutta.
(5) All communications regarding the purchase or adjustment and use of instruments.	S. WOODHOUSE, ESQ., 1, Little Russell Street, Calcutta.
(6) All other communications including periodicals or books of review.	The Secretary, P. N. MUKERJEE, ESQ., M.A., Imperial Secretariat Building, Calcutta.
(7) Communications as to particular observational work or relating to any of the Sections.	The Director of the Section.

They are—

General Section . .	DR. E. P. HARRISON, Presidency College, Calcutta.
Lunar Section . .	REVD. J. MITCHELL, M.A., F.R.A.S., Wesleyan College, Bankura.

Meteor Section . .	B. M. RAKSHIT, ESQ., B.A., 77-3, Musjid Barry Street, Calcutta.
Variable Star Section .	MAJOR LENOX CONYNGHAM, R.E., F.R.A.S., United Service Club, Calcutta.
Photography . . .	R. J. WATSON, ESQ., 37, Park Road, Barrackpore.

Papers to be read at Meetings.

It is requested that papers to be read at Meetings may, as far as possible, be written on paper of foolscap size and on one side only. They should be in such condition as to need no corrections or alterations, and when they are accompanied by lantern slides, references to the latter should be given in the margin in order to show where they apply. Slides to be returned should be so marked on the cover of the box.

They should be sent as early as possible before the day of the Meeting.

The Library.

It is essential that a Library should be got together as soon as possible, and as the subscriptions are too low to provide for this in addition to the other expenses of the Society at present, donations are asked for to enable a beginning to be made. Some have already been received and a number of books have been ordered. It is hoped, however, to make the Library available not only to members in Calcutta, but also to those in other parts of India on the payment by them of the postage, and to enable this to be successfully carried out, it will be necessary to have the Society's shelves well stocked. Suggestions as to the names of publishers and prices of useful books will also be welcomed from members by the Librarian.

Observing Sections.

The Directors of Sections have given an outline of the work they propose to take up. Members who intend to take up work are invited to communicate with the Director of the Section they select as soon as possible, so that they may receive detailed instructions and information. They should at the same time state the kind of instrument they possess, if any. As the fine nights of the year are now at hand, no time should be lost in sending in the names.

Lunar Section.

There will be a total eclipse of the moon on the morning of the 17th November 1910. Those who possess instruments and will observe it are requested to communicate as soon as possible with the Director of the Lunar Section, in order that they may receive information as to the special features to be observed.

Instruments.

In view of the numerous requests for advice regarding the purchase and capabilities of instruments, the Council have appointed Mr. S. Woodhouse as Instrumental Director. He will be happy to assist those who desire advice in selecting an instrument.

Applications for Membership.

Forms can be had from the Secretary. It is necessary for each applicant to be proposed and seconded by a member; one of whom must have personal knowledge of him. If, however, the applicant does not know a member, he should apply to the Secretary, giving a reference to some well-known person when he can be elected.

Subscriptions.

Members are requested to pay in their subscriptions to the Treasurer for the year 1910-1911 as early as possible, if they have not already done so.

Meetings.

The Ordinary Meetings of the Society will be held on the following dates :

1910.	1911.
October 25th	January 31st
November 29th	February 28th
December 21st.	March 28th
	April 25th
	May 30th
	June 27th

The Meetings will commence at 5 p.m., and until further notice will be held in the Imperial Secretariat (Treasury) Buildings, Calcutta.

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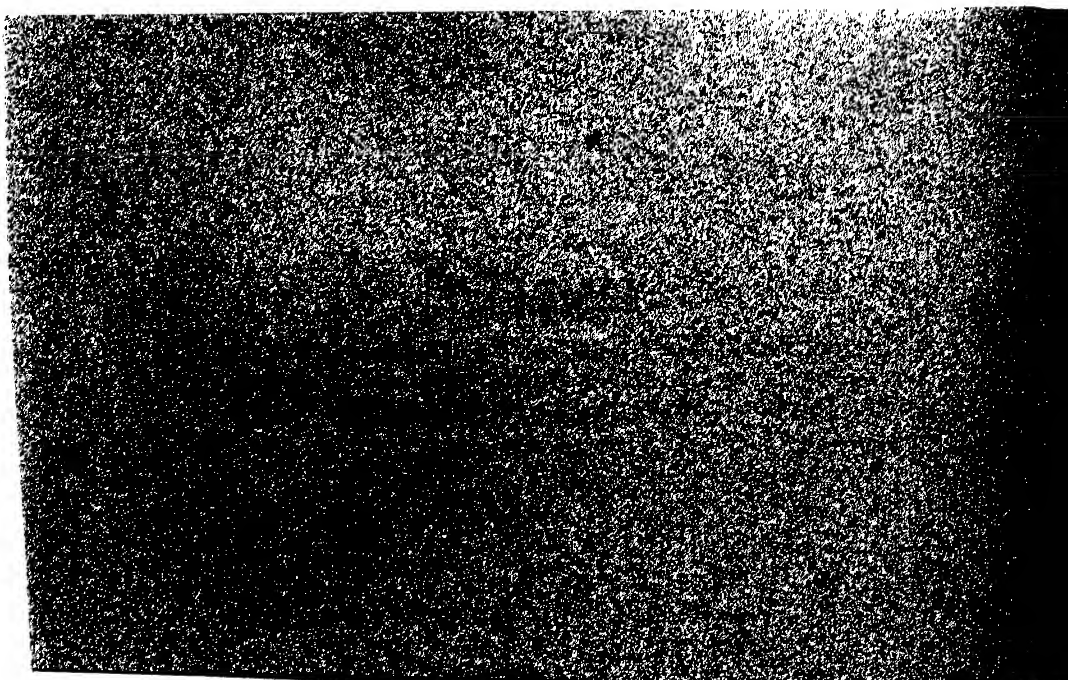


The Journal
of the
Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 2.

Report of the Meeting of the Society held on Tuesday, the 29th November 1910.

H. G. TOMKINS, F.R.A.S., *President*, in the Chair.

P. N. MUKERJEE, M.A., F.S.S., *Secretary*.

Mr. Mukerjee read the minutes of the previous Meeting which were confirmed.

It was announced that the following presents had been received :—

The Bulletins, Memoirs and Annual Reports of the Kodai Kanal Observatory from the first number up to date—From the Director.

Four papers, on Halley's Comet, the total Eclipse of the Sun, and the Transit of Mercury in 1907—From Professor Emanuelli of Rome.

The thanks of the Meeting were accorded to the donors.

The election by the Council of the following ladies and gentlemen as members of the Society was confirmed :—

1. MR. H. W. BRYNING.
2. ,, W. I. BRYNING.
3. ,, M. R. COBURN.
4. ,, E. G. DRAKE-BROCKMAN.
5. MRS. GRIFFITH.
6. MR. LEWIS H. HARRISON.
7. ,, G. McDOUGALL.
8. ,, J. H. MANNING-FOX.
9. MR. BHUPENDRA NATH MITRA.
10. ,, H. P. MITRA.
11. ,, S. C. MITRA.
12. ,, G. N. MUKHERJEA.
13. ,, R. D. MURRAY.
14. ,, H. BHIMSENA RAU.
15. ,, B. K. PAL.

The President then announced that at the previous Meeting of the Council it had been decided that the time had come to take further definite steps towards the progress of the Society. There were now over 200 members, and so far progress had been satisfactory in every way. Considerable interest had been taken in the Society, and members were not only taking up lines of work, but several of them were purchasing instruments with a view to obtaining observations. There were several interesting papers to be read that evening, and it was a very encouraging thing to find some of them from the pens of Indian members. An English amateur was not a thing unknown even in India, but an Indian amateur was rarely met with, and it was very satisfactory to see Indian members also coming forward as pioneers in this direction. He hoped that they would continue their efforts, and that many would be added to their numbers. They would always receive every encouragement from the Directors and Council.

The President further said that there were three definite directions in which members could help on the Society, both in Calcutta and all over India.

The first of these was the increase in the membership. This was necessary, both in order to obtain a general interest in the work of the Society, and to produce a wide field of workers as well as to provide the 'sinews of war' in the shape of funds. The subscription of Rs. 8 a year had been fixed very low to enable as many as possible to join, and it was considered better to have a good number of members on a low subscription than a small number on a high one. It was necessary for members to do all they could to increase the membership of the Society. Those who were not in Calcutta would have the Journals and other publications of the Society which, it was hoped, would contain beside the doings of the Society itself, some account of things that were going on in the astronomical world in this and other countries. The Council were issuing a circular in India very shortly, but members themselves could also greatly assist by obtaining forms of application from the Secretary and helping them to swell the membership. He would like to see at least a thousand members as soon as possible. A form of application would be sent with each copy of the next Journal. Two other directions were—the Library and the provision of Quarters for the Society.

The Library would, it was hoped, be available to members both in and out of Calcutta. Some books had been sent for, and the Council had arranged to open a special donation list for the purpose of putting this branch of the work on a sound footing as soon as possible. There were many members

who could afford to back up their scientific interest to a larger extent than the subscription of Rs. 8 a year, and in directing their attention to Bye-law No. 63, he hoped that donations would be freely given to enable the Librarian to stock his shelves for the general benefit of members at the earliest possible moment.

In the matter of Quarters also funds were required. If the membership of the Society substantially increased, probably this question would solve itself; but for the present it would be necessary to rely on donations in order to tide the Society over the initial cost of rent and furniture. A good deal of property had already accumulated, and it was desirable that there should be some proper place to put it. Very shortly indeed also a reading and writing room would be wanted, and consequently a donation list had also been opened for this purpose by the Council.

Donations would be strictly ear-marked for the purpose for which they were given, *i.e.*, Library or Quarters, and might be sent to the Treasurer.

The President concluded by remarking that after the formal meetings he had noticed that members often remained for a short time, and interesting informal interchanges of ideas took place. He invited others to do the same, and said that he hoped this spontaneous addition to their meetings would grow, as it was a very pleasant way for members to obtain information, and to get to know one another.

The President then called on Mr. Rakshit to tell the Meeting how he had fared with the recent Meteor showers.

Mr. Rakshit said the showers on the whole had been very disappointing and very few meteors had been seen. Probably the moonlight had something to do with this, but his opinion was that the showers themselves had been poor.

The President having asked if other members had seen anything of the showers—

Mr. Howse said he had not seen any. Other members generally agreed that there were very few meteors, though some of them had seen a few scattered ones.

Mr. Rakshit then read a note on the observation of the next shower in December.

Several papers were then read on the total Eclipse of the Moon which took place in the early morning of the 17th November 1910 (Standard Time), and Mr. Woodhouse showed several photographs of the Eclipse taken by Mr. Edmonstone and himself with the instrument at the Presidency College kindly placed at the disposal of the Society by the College authorities.

The Vice-President, Mr. Saroda Charan Mitra, having then taken the Chair, Mr. Tomkins put four photographs of the Eclipse taken by him at Barrackpore on the screen.

The President having re-occupied the Chair, the Director of the Lunar Section next read some notes made by himself, and generally summed up the impressions which the Eclipse and papers read had left on his mind.

The President.—We have listened to a series of very interesting papers on this Eclipse. It seems evident that the shadow in Calcutta was exceptionally dense and that very little detail was seen in it. At Bankura, however, Mr. Mitchell seems to have had it lighter and more transparent.

Mr. Mitchell.—I think it is evident that we had better conditions at Bankura. The dark patch at Grimaldi and the light ones at Menelaus and Delambre were clearly visible.

Mr. Banerjee.—I noticed the dark patch, but not the light ones. The only bright patch in the shadow seen by me was Aristarchus.

Mr. Ramaswamy.—I also noticed the dark patch. Aristarchus was the only light patch I could see. Also the only bright rays I could see were those from Tycho towards Bullialdus.

Mr. P. C. Bose remarked that the shadow was very dense and very little detail could be seen in it.

The President then invited discussions on the appearance of the rays.

Mr. Banerjee.—The only rays I could see were the two just mentioned by Mr. Ramaswamy. The others were blotted out almost at once by the shadow, which was also very irregular.

Mr. Sarkar.—I also noticed the irregularity of the shadow and should like to know what it may have been due to. The shadow was certainly very dense in Calcutta.

Mr. Mitchell.—I do not agree as to the density of the shadow; it seemed to me to be about as light as usual in eclipses. The light spots mentioned by me before were visible, and the dark outlines were also clearly visible all through the Eclipse.

The President.—Yes. I can bear out the visibility of the dark portions of the Moon.

Lt.-Col. Conyngham.—Is it generally considered that the light rays are elevated above the general surface of the Moon?

The President.—It is a matter which is at present under investigation. I have had some of the rays under observation for several years, notably the two long ones running north from Copernicus, and many of them are undoubtedly

very slightly elevated ridges. The object of ascertaining whether they are elevated or not is to find out their origin, which is possibly not due to the same cause as their colour, though the two are connected.

Mr. Mitchell remarked that one thing he noticed about the irregularity of the shadow was the way it was blunted at the horns.

Dr. Harrison.—I think that is what one would expect from the conditions of the Eclipse. (Dr. Harrison then illustrated the case on the black board.)

The President.—The photographs bear out Mr. Mitchell in his observation.

Mr. Mitchell.—Yes. Dr. Harrison's is no doubt the explanations of the peculiarity.

Dr. Harrison then asked if the cause of red tint of the Eclipse had been explained.

The President.—I think it is usually attributed to the earth's atmosphere.

Dr. Harrison.—I don't quite see how the earth's atmosphere could account for all of it (black board). I should like to investigate it further.

Col. Conyngham then showed two photographs of Halley's Comet taken by Mr. Taylor of his office, and explained that the plate used was one of Eastman's Special Ultra Rapid bathed in Pinacyanol. This renders the plate sensitive to the Cline in the red. The plate was exposed for 40 minutes and developed with Pyro Soda.

The President.—I notice a very remarkable streak up the middle of the tail; it is undoubtedly a valuable photograph.

Lt.-Col. Conyngham.—Yes: the streak is one of the main features of the photograph.

Mr. Mitchell.—May I ask a question about the bright star in the tail? What was the exact position of the Comet at the time of the photograph?

Lt.-Col. Conyngham.—I am afraid the time was not recorded, but possibly Mr. Taylor might know it.

Lt.-Mr. Mitchell.—The reason I wish to know is that I observed a bright star very nearly occulted by the Comet's head, and I think that it may have been the one in the photograph. It appeared to brighten rather than diminish when near the head.

Mr. Woodhouse then showed results of an attempt he had made to get a photograph of the constellation Cassiopeia with the instrument at the Presidency College.

The Meeting was then adjourned until 5 p.m. on the 21st December 1910.

Outline of Work on Variable Stars.

By the Director of the Section.

By a 'Variable' Star is meant one of which the apparent brightness as seen from the earth is not constant. No other kind of change—such, for instance, as change of position—is taken into account when we are considering the variability of stars.

The brightness of a star is expressed by a number which is called its magnitude. This does not mean magnitude in terms of measurable dimensions, for not even in the largest telescopes have any stars discs of sensible size—they are all mere points of light. Star magnitudes are merely numbers by means of which they can be classified according to the amount of light that we receive from them. This amount of light may depend on the inherent brightness of the stars, or on their distance from us; but in assigning magnitudes we are not concerned with the causes of the differences, but merely with what we see. The numbers denoting magnitudes increase as the brightness of the stars diminishes: thus a big star has a small number assigned to it, a first magnitude being brighter than a second, a second than a third, and so on.

In early days a rough classification into first, second, third, etc., magnitudes was all that was attempted; but by degrees this has been refined upon, and now a star magnitude is given to one or even two places of decimals.

Thus a standard first magnitude star will have the number 1 assigned to it, a second magnitude star the number 2, and so on; and between them will be stars of magnitudes, such as 1·25, 1·60, 2·38, etc. A number, such as 1·25 for instance, implies that the star is less bright than a first magnitude and brighter than a second magnitude, and that on the scale of brightness it lies one quarter of the way from 1 towards 2.

The most generally accepted scale of brightness connecting the magnitude with the amount of light received, is that proposed by the late Mr. N. R. Pogson, the eminent astronomer who was for so many years in charge of the Government Observatory in Madras.

He proposed a factor of 2·512, used in the following way:—Given a standard star of any magnitude as a starting point, a star one magnitude above it on the scale will be one from which we receive 2·512 times as much light as we do from our standard; or, if we go down the scale, then a star one magnitude below the standard will give an amount of light = that of the standard divided by 2·512; a

star two magnitudes below the standard will give an amount of light = that of the standard divided by $(2{\cdot}512)^2$, and so on.

The logarithm of $2{\cdot}512 = 0{\cdot}4$, hence log. $(2{\cdot}512)^5 = 2{\cdot}0 =$ log. 100.

Therefore the light we receive from a 6th magnitude, being = light from a 1st magnitude $\div (2{\cdot}512)^5$, is $\frac{1}{100}$ of the light of a 1st magnitude, and the light from an 11th magnitude is $\frac{1}{10000}$ of that of a 1st magnitude; that is to say a descent of five magnitudes divides the light received by 100, and so on.

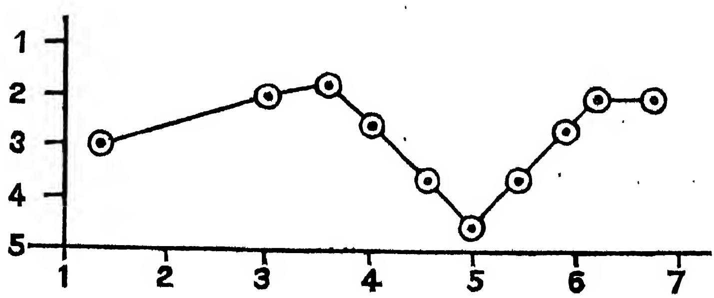
There are stars of greater brightness than those of magnitude 1; if a star gives 2·512 times the light of a 1st magnitude, it is said to be of magnitude 0, and one giving 2·512 times the light of a 0 magnitude would be said to be of magnitude −1.

The majority of the stars shine with a steady blaze, but so long ago as the year 1596—speaking of European Astronomy, of the much older Indian science, the writer has unfortunately no knowledge—the first variation in a star's brightness was observed. This was in the case of the remarkable star ° Ceti, or Mira. Some 70 years later the variability of β Persei (Algol) was discovered, and since then new variables in ever increasing numbers have been recorded. At the present day the number of known or suspected variables is very large.

The next step, after having learned that the brightness of many stars is variable, is to follow the course of the changes and to record them in such a way as to throw light on their nature, and, if possible, to reveal the laws which govern them.

The process of recording the variations is called "drawing the light-curve" of the star. This is done as follows:—

A horizontal line is drawn and divided off into equal parts to represent intervals of time, and a vertical line is marked off to represent star-magnitudes.



If now at a time half way between epochs 1 and 2 (for instance) the magnitude of the star is 3, we plot a point vertically above 1·5, and in a horizontal line through 3. A later observation at time 3 shows, we may suppose, that the star was then of magnitude 2; this gives another point. By continuing the observation and noting the star's magnitude at different times we obtain a series of points, indicated in our imaginary diagram, and by joining them we obtain a curve which represents graphically the course of the star's variation. This is called its light-curve.

The above is, the writer believes, the way in which light-curves are invariably plotted—that is to say, with a vertical scale of equal parts to represent magnitudes. This seems to imply that the loss of light is the same in amount for each drop of one magnitude, which is not the case. Such a curve is not, strictly speaking, a light-curve; it is a magnitude-curve. To obtain a true light-curve, one should first decide on the number of parts of the selected scale to represent the light of a first (or other) magnitude star, and then the numbers to represent the light of lower magnitudes would form a series in descending geometrical progression.

True light-curves would have flatter minima and steeper maxima than magnitude-curves.

However, since the simple method of plotting by magnitudes is in general use, it will be well for the Astronomical Society of India to adhere to it.

The light-curves—using the term in the customary way—of many stars have been drawn, and it has been found that the curves fall into four principal classes, denoting variable stars of four different kinds. They are :—

(1) Algol type.
(2) Short period, non-Algol.
(3) Long period.
(4) Irregular.

The Algol type of curve, so called after the celebrated star of that name, has the following characteristics :—There is considerable period without change, then a rapid descent to a minimum, a brief, often scarcely discernible, period of steadiness followed by a rapid rise to the former level: again a prolonged quiescence and then a repetition of the changes.

Curves of class 2 differ from the above in that there is no period of steadiness. The changes are continuous, but repeat themselves in a moderate time—less than about 70 days.

Class 3 is not sharply divided from class 2, but the period is much longer, extending from about 140 days up to several years.

There do not appear to be many, if any, stars with periods between 70 and 140 days in length. Hence the adoption of 70 days as a sort of rough limit to periods which are classed as short.

Class 4 consists of stars which either show no recurring periods in their variations, or periods of such length, or curves of such complexity, that no law has as yet been ascertained.

For the determination of the light-curves of stars the important thing is to secure a number of observations spread in a continuous manner over a long time: for this reason, co-operation is specially valuable, the gaps in one observer's record being filled by the results obtained by others in perhaps different localities where the vicissitudes of the weather have been different. It is also very important that the attention of a good many observers should be concentrated on a small number of stars.

The method of observing a variable star is very simple. It consists merely of making comparisons between the variable and neighbouring steady stars of which the magnitude is known.

The best plan—though it may not always be feasible—is to select two comparison stars, one somewhat brighter and one somewhat fainter than the variable, and to estimate by what fraction of the difference between the two steady stars the variable is fainter than the one and brighter than the other. Thus, if the comparison stars are A and B, we might estimate perhaps that V was fainter than A by about a quarter of the amount of the difference between A and B.

If, therefore, the magnitude of A were 3·4, and that of B 5·6; interval 2·2. The magnitude of V would be—

$$3{\cdot}4+2{\cdot}2\times\tfrac{1}{4}=3{\cdot}95$$
$$\text{or } 5{\cdot}6-2{\cdot}2\times\tfrac{3}{4}=3{\cdot}95.$$

The record of an observation should contain the following particulars:—

Date and Time—Stating whether Standard, or Calcutta, or other local time is given.

State of Sky—Good, inferior (cloudy or hazy), very poor. M should be added if there is moonlight and Tw if there is twilight.

Instrument—Eye, Binocular, Telescope, stating magnifying power.

Class of Observation—First class, moderate, poor.
Name of Star observed—
Names of Comparison Stars—
*The record of the observation.**

The first and greatest difficulty that confronts a beginner is that of identifying his stars. For that reason, in the programme of stars which is here put forward, visibility has been the chief consideration kept in mind.

Seven stars are selected as suitable to make a beginning upon. Particulars with regard to them are given in the following table and notes :—

Star.	R.A.		Declination.		Period.	Limits of Magnitude.
	H.	M.			D.	
β Lyræ ...	18	46	+33°	14′	12·91	3½ — 4½
R (13) Lyræ ...	18	51	+43°	48′	46	4 — 4¾
η Aquilæ ...	19	47	+ 0°	43′	7·17	3½ — 4¾
S (10) Sagittæ ...	19	51	+16°	20′	8·38	5½ — 6½
μ Cephei ...	21	40	+58°	16′	irregular	3¾ — 6
δ Cephei ...	22	25	+57°	51′	5·37	3¾ — 5
Algol (β Persei) ...	3	1	+40°	32′	2·87	2·2 — 3·7

For β Lyræ, see Plate VI of the Astronomical Society of India's Star Chart. This star is easily found, being near the conspicuous star α Lyræ (Vega).

Comparison stars. γ Lyræ magnitude 3·2
δ^2 Lyræ ,, 4·5

For R (13) Lyræ, see A. S. I. Chart I, on which it is marked 13.

Comparison stars. γ Lyræ magnitude 3·2
δ^2 ,, ,, 4·5
(16) ,, ,, 5·2

For η Aquilæ, see A. S. I. Chart VI.

Comparison stars θ Aquilæ magnitude 3·4
μ ,, ,, 4·7

* The above is taken from the Journal of the British Astronomical Association.

The constellation Sagitta is to be found on A. S. I. Chart VI, but the star S (10) is not marked, its position on that chart would be about 2 mm. to the left of the G in the word Sagitta, and 3 mm. below the e in 'neb.' There is a convenient comparison star (11) close to it, a little to the north and preceding—magnitude 5·3. These stars will be rather difficult to pick up with the naked eye, but will be easily seen with a binocular.

For o and μ Cephei, see A. S. I. Chart I.

Comparison stars.	ζ Cephei	magnitude,	3·5
	19 ,,	,,	5·2

Algol (β Persei) is also to be found on plate I.

Comparison stars.	α Persei	magnitude	1·9
	ε ,,	,,	3·0
	ν ,,	,,	4·0

Outline of Work for the General Section.

BY THE DIRECTOR OF THE SECTION.

It is suggested that an excellent object for observation by members of the General Section is the Sun.

Persons living in India are naturally very favourably placed for making such observations; moreover, the size and comparative nearness of the Sun make it possible for good work to be done even by those who are indifferently equipped as regards instruments.

For the sake of definiteness, I shall describe briefly a line of investigation along which members of the Society might with some advantage direct their attention, and which is likely to yield valuable data.

Spots on the Sun's surface have always been a fascinating subject for study, and the general observation of both sunspots and faculæ is open to everyone possessing a small telescope. Drawings of these disturbances in the luminous envelope of the Sun can always be obtained by the method described at the end of this article, while for those possessing larger instruments, there is an opportunity for more detailed study, with the help, possibly, of the photographic plate.

Such sketches or photographs are always of value, especially when the records extend from day to day as they should do.

Members should remember most particularly and *in every case* to record the local time at which the sketch was made and to append the date. For those using small instruments without cross wires or declination circles, the approximate position of the spot at the time of drawing may be indicated by sketching in the whole solar disc, and subsequently dividing it up into squares on the drawing.

Observations such as these may be useful as giving details at different times of the *form* of a particular spot, facula, or group of spots.

In addition to work of this nature, it is possible that many members of the Section may care to undertake a more systematic series of observations and to attempt to obtain data which may be of value in the decision of some definite point of controversy in the field of Solar Physics.

Questions, for example, of the real origin of sunspots, and of the possible connection which may exist between their origin and the attraction of certain planets, would come under this heading, and much can be done towards the solution of these problems by systematic observations of the time of appearance of new spots, and of the growth to a maximum intensity of spots which have already appeared.

As a matter of actual practice the data wanted are—(1) the local time of appearance of any new spot combined with daily drawings of its shape and apparent structure, and (2) the appearance and position of old spots, the drawings in both cases to be accompanied by a note of the local time and the date.

The heliocentric longitude* of the spot should also be observed by those with suitable instruments. Failing that, observers may note the time and date of the disappearance of a spot over the edge of the Sun's disc.

Data such as I have described, when a sufficient number of observations have been accumulated (especially at the time of the eleven yearly periods of sunspot maxima) may be used in testing Birkeland's theory of the origin of sunspots and in finding the period of rotation of the supposed solar nucleus. Birkeland supports the theory of a solid solar nucleus, whose time period is different from that of the gaseous envelope. Violent disturbances in equilibrium between the solid and gaseous portions of the Sun are supposed to have their seat in certain very well defined crater-like tracts on the surface of the nucleus, and these disturbances are what we see as spots on the surface of the photosphere. By

* The heliocentic longitude is the longitude of the spot as seen by an observer at the Sun's centre.

an ingenious method of dealing with the relative motion of the photosphere and the supposed solid nucleus, Birkeland is able to assign to each spot-area on the photosphere a definite crater-area on the nucleus, the crater-areas being apparently persistent in position for many years. Further data as to the position and place of appearance of new spots are wanted in order to test the validity of results already obtained, hence the suggested series of observations, which would probably afford interesting work for a good many years.

As regards the method of observing the Sun. By those with large instruments the direct method may be used, or the photographic.

In the former case, it is perhaps worth while to warn those who are unfamiliar with this kind of practical work of the extreme importance of protecting the eye with a piece of dark glass when making observations of the Sun with a telescope.

A very convenient way of obtaining drawings of the Sun's disc, and of spots which may exist thereon, is to allow the direct rays of the Sun, after passing through a hole in a window shutter or screen, to fall on the object glass of the telescope in the ordinary way, and then to place a piece of drawing paper at the eye-piece end of the instrument instead of the eye.

A real image of the Sun will be formed on the paper and may easily be sketched, provided the paper is steadily supported on some convenient stand. By varying the distance between the eye-piece and the paper, and by suitably focussing the former, the size of the image may be varied at will.

Observations of the Eclipse of the Moon, November 17th, 1910.

By the Director of the Lunar Section.

It is intended in these Notes to give a summary of the observations made of the above Eclipse rather than a categorical series of observations made in order of time.

Place—Bankura.

State of Sky—Perfectly clear. Definition not quite perfect.

Instrument—A $3\frac{1}{2}''$ refractor. Power 70.

Time—S. T.

Special features of Eclipse.

1. *Shadow not very dense.*—It was impossible to say when the shadow (Umbra) came in contact with the Moon. The edge of the Moon was easily visible until 4-32 a.m., *i.e.*, until about 18 minutes after the real contact. At first the penumbra shaded gradually into the Umbra, though at a later stage in the Eclipse, the line of demarcation was more pronounced.

2. *Grimaldi.*—A striking feature in the early stage of the Eclipse was the prominent way in which this walled plain stood out in the shadow. This remained visible until 4-59—that is, when a little more than half the surface of the Moon was covered.

3. *Edge of the Shadow.*—The edge was not sharp, being a little fuzzy and not quite uniform in the early stages. Moreover, at first it was distinctly bent downwards at the ends, the northern end remaining bent longer than the southern end. At 5-6 the edge of the shadow was quite regularly curved. As the shadow travelled over the seas, the edge was sharper in those regions than elsewhere.

4. *Aristarchus* was brightly visible until 5-18 and more faintly visible up to 5-34. Had the Moon been at a higher altitude, there is no doubt that it would have been seen easily right through totality. It was by far the most prominent feature in the shadow. Of other spots, Menelaus and Delambre were fainter, but about equal in brightness, and remained visible until totality was almost reached. Copernicus remained visible in the shadow for at least 5 minutes. Tycho was blotted out almost immediately it was immersed in the shadow.

5. *Rays.*—The rays of Copernicus were visible for only a few minutes, but the two rays running north from Tycho remained quite prominent for 17 minutes after the shadow had passed over them. After this they rapidly disappeared. The appearance of these two rays was a striking feature of the Eclipse. They were most prominent some distance from Tycho and before reaching Bullialdus.

Up to 5-18 all the main outlines of the Moon were visible in the shadow, the neighbourhood of Sinus Iridium being somewhat prominent.

At 5-36 there was but a faint streak of light left, yet totality was not reached until 5-43.

A star, about magnitude 7, was seen a little distance from the east edge of the Moon at 5-34. An occultation would have been seen had the Moon not been so near the horizon.

The colour of the shaded portion of the Moon, as in the last Eclipse I observed in England, was of a coppery hue.

BY A. M. URQUHART.

Place of observation—Ishapore.

Instrument—3½″; magnification 60.

State of Sky—Cloudless, but slightly hazy.

At 3-50 a.m. (*S. T.*) the glare on the eastern edge of the Moon was distinctly reduced and noticeable to the naked eye. At 4-16 the contact with the shadow was distinct. As the shadow advanced over the lunar disc, its edge appeared fairly regular but not distinctly defined.

The rays from Tycho and Copernicus did not show up well, as the shadow covered them and were almost invisible after being covered up. The most conspicuous object was Aristarchus. The colour of the Eclipse was an earthy reddish-brown gradually getting more opaque until, when the disc was covered, the eastern edge was invisible.

By the time of totality the approaching daylight and the haze rendered the features of the Moon indistinct.

There were no occultations visible.

BY H. B. HOLMES.

My observations were made at Barrackpore. I had the use of a theodolite and a pair of ordinary field glasses. The night was particularly clear and no indication of any haze or smoke.

The Moon, when observation started, was bright, but nothing peculiar was noticeable. At 3 a.m. the dark markings appeared to gradually intensify. At 3-15 a.m. there was a distinct diminution of the Moon's brilliancy at the portion indicated from XI to XII on the face of a clock, as if a thin dark smoke was creeping over. This advanced gradually downwards, being darker near the top. After the contact with the shadow, and as the shadow travelled onward, this smokiness gradually yellowed, being more opaque near the edge of the shadow.

It was difficult to actually determine the exact time of the first contact with the shadow.

The shadow, when it became evident, was of a dark grey colour, and this same dark grey shadow was apparent until it had got quite half way down the Moon's surface. It then began to gradually attain a reddish hue. This ruddiness began to grow more pronounced as the shadow slowly advanced, and was always more marked nearer the first point of contact than the edge, which retained the same dark grey colour throughout the transit as first noticed. After totality the entire lunar surface was a graduated copper colour.

The actual time of totality was again difficult to determine. There was a thin thread of brightness which seemed to take a longer time to eclipse and which led one to imagine that the shadow had stopped creeping.

One peculiarity noticeable was that after totality there remained for some little while a bright coppery streak at the lower edge of the Moon, extending from VI to II o'clock, and considerably brighter than any other portion of the disc.

I noticed no bright spots otherwise.

I noticed nothing peculiar in the appearance of the light rays at any time.

As the ruddiness became less dense as the Eclipse progressed, the usual dark patches on the Moon were discernible through the shadow.

To me it appeared as if the first contact with the shadow took place midway between XI and XII, that the shadow advanced steadily in a diagonal line straight down the surface of the Moon until it came in contact with the lower edge between VI and V.

The Sun had risen over the horizon shortly after the commencement of totality, and a noticeable feature was the way the Moon seemed to gradually dissolve into the atmosphere; the portion which had been first eclipsed disappearing first, the disc slowly turning from copper to blue.

The following morning I again observed the Moon, and though it was later and the Sun higher, the Moon stood out bright. On neither morning was there any indication of smoke or haze.

During the observations, 3 Leonids and 1 Andromid were counted.

The night was still and clear: there was a very heavy dew and the thermometer registered between 62° and 63°.

BY C. N. RAMASWAMI.

Members of the party:—MESSRS. N. V. RAGHAVAN, C. N. RAMASWAMI AND K. JAGADISAN.

Place of observation—69-1, Serpentine Lane.

Instrument—2½ inch refractor.

The sky was very clear throughout the period of observation.

Nothing peculiar was observed until about ¼ of the Moon's disc was in shadow, when the portion in shadow assumed a reddish tinge, which, however, gradually disappeared in about 5 minutes.

The shadow was very dense and no details were visible within it, and it was with difficulty that the shaded portion of the Moon could be distinguished from the sky.

When Copernicus had disappeared within the shadow, it was observed that one of the 2 rays proceeding from Tycho towards it (the left one) continued to be visible within the shadow for some 10 to 12 minutes; and there was just a suspicion that the end of it was forked.

The rays proceeding from Kepler were found to disappear completely as the shadow advanced. Bright spots in the dark portion and occultations were looked for, but none could be observed.

Four or five Meteors were noticed but none were recorded, as we were busy observing the surface of the Moon.

BY U. L. BANERJEE.

1. *Telescope used*—4″ aperture. One binocular was also used.

2. *Place of observation*—Top of the Hare School, Calcutta.

3. *Atmosphere*—Clear. Lower part of western sky was somewhat misty.

4. *At 4 a.m.*—Moon was observed. No sign of the shadow. Viewed through the telescope the edges of the Moon appeared ragged, showing unevenness of its surface. Rays radiating from Tycho. Two bright spots at (Proclus) and Atlas. There was a dark patch at Plato and Grimaldi detached from other dark places.

5. *At 4-14 a.m.*—First contact with the shadow. No stars were visible in the neighbourhood. Darkened part gradually assumed smoky violet colour.

6. *At 4-40 a.m.*—The upper part of the darkened portion began to change colour and appear reddish.

7. *At 4-50 a.m.*—Shadow appeared at Tycho. Rays round it gradually got fainter and fainter although distinctly visible.

8. As the Moon was advancing into the shadow, the upper part was getting brighter and brighter and the colour appeared reddish.

9. *At 5-16 a.m.*—The cap of the Moon seemed distinctly red in colour.

10. *At 5-18 a.m.*—Shadow approached Proclus.

11. *At 5-20 a.m.*—Colour was distinctly red to naked eye. Craters were visible at Proclus end of the Mare Serenitatis.

12. *At 5-25 a.m.*—As shadow was advancing towards totality, the red colour was covering the whole of the darkened portion.

13. *At 5-29 a.m.*—Rays round Tycho not visible. No stars could be seen, as the eastern horizon was then getting brighter and brighter.

14. As the shadow was approaching totality, the first contact part was getting fainter and fainter.

15. *At 5-50 a.m.*—Occurred the totality. The Moon was almost visible, as the eastern horizon was then red on account of approach of the Sun.

16. End of the total phase and last contact with the shadow could not be seen.

17. Atmosphere was very chilly at the time.

BY H. CONNELL.

Place of observation—The roof of the Hare School, Presidency College, Calcutta.

Instrument—A Cooke telescope of $3\frac{1}{2}''$ clear aperture, having a pancratic erecting eyepiece giving magnifications

between 50 and 90 discs, mounted on an altitude azimuth stand.

Standard Time used.

It was noticed that the first darkening of the lunar surface was much sooner and easier detected by unaided vision than by observation with the telescope.

The first noticeable contact with the actual shadow of the earth took place at 4-12 a.m. As the eclipsed portion grew in size it assumed a dark, muddy, slightly green colour when viewed through the telescope.

At 4-17, and for some time afterwards, the outer edge or rim of the advancing shadow appeared to be of a darker shade than the rest of the eclipsed area.

The crater Aristarchus stood out particularly bright even after that portion of the Moon's face was completely enveloped in the earth's shadow; in fact up to 5 o'clock its sharp point of light was quite conspicuous.

When the edge of the shadow was about half way across Mare Serenitatis, at 5-3 the clump of small craters on the side nearest Proclus stood out very clear for a time, this being due to the reduction of the glare.

Also when Proclus was first touched by the shadow, the face it presented to the oncoming umbra became quite dark, whilst the two adjacent sides continued to be comparatively bright. From its appearance at this time there was left no doubt but that the three lines of light seen radiating out from the centre of Proclus under ordinary conditions are really three ridges leading from the lower levels up to the peak. As the Eclipse approached totality, just before dawn, the shadowed surface of the moon flushed to a lovely red.

BY H. G. TOMKINS.

Place of observation—No. 9, Riverside, Barrackpore.

The party of observers consisted of Mr. Holmes, Mr. and Mrs. Percy Brown, Mr. and Mrs. Watson, Mrs. Tomkins and myself.

The instruments used were an $8\frac{1}{2}''$ reflector adapted for photographing the Eclipse, a $3''$ refractor, a $1\frac{1}{4}''$ theodolite and several pairs of field glasses.

The night was clear except for a very slight haze at intervals, which made definition sometimes rather unsteady.

There was a considerable amount of dew.

On the whole, however, the night was good.

The first indication of the Eclipse was seen at 3-21 Standard Time, when the features on the Moon visible to the naked eye stood out rather more clearly than usual and appeared to have a darker tint than before. The penumbra advanced very slowly, and it was not until about 10 minutes before the contact with the shadow that it became clearly visible as a yellow, muddy looking shading east of Copernicus.

The temperature was 63°.

The contact with the shadow was plainly evident at 4-13-45.

The shadow was then dark grey and it was possible to see the rays from Tycho towards Bullialdus in the depth of the penumbra. They appeared to be distinctly elevated about the general surface of the Moon.

At 4-33—The shadow had turned to a copper tint and Aristarchus was faintly visible in the shadow as well as the two rays just mentioned.

At 4-46—The shadow had a decided copper colour. It was possible to see slight detail in the shadow, but except for the two rays above mentioned, there was not much except the darker features visible.

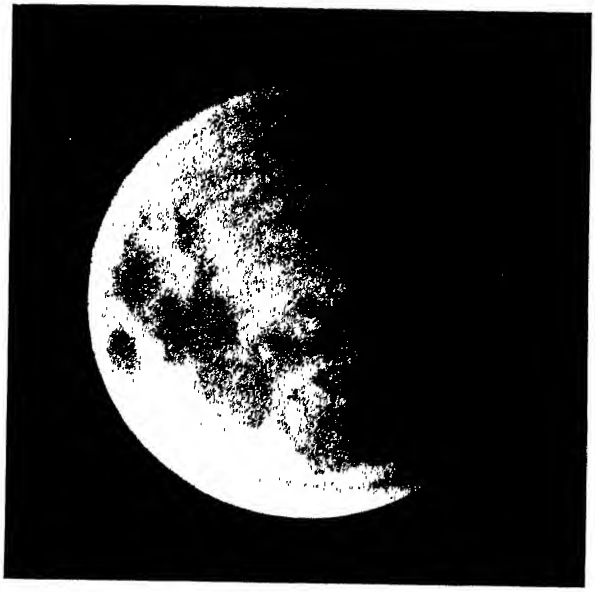
At 4-54—The shadow had grown very red and bright.

Totality was difficult to observe owing to the intervention of daylight. As near as could be made out, it was between 5-43-30 and 5-44-30.

There was an exceptionally high tide at Barrackpore and the temperature at daylight was 61°.

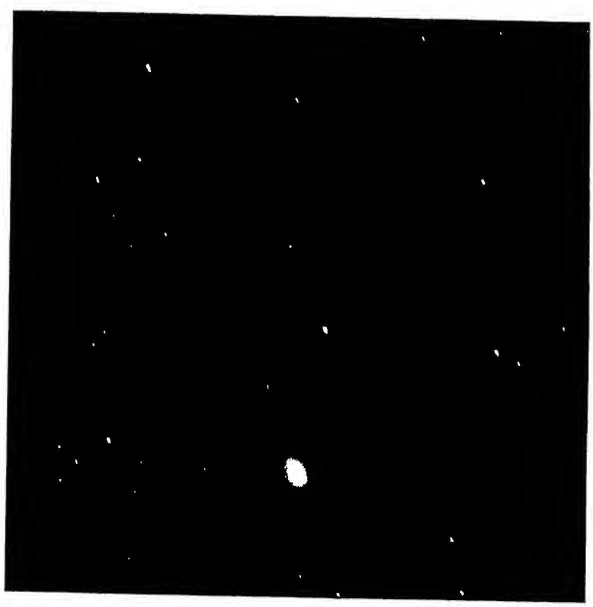
The main features of the Eclipse were its dense shadow and the lack of detail in it. Only Aristarchus, the seas, and very faintly the two rays from Tycho to Bullialdus were visible. The shadow was a bright copper colour and light in tint. It darkened from copper to indigo in a most peculiar manner as the Eclipse became total and daylight approached. The gradation from the penumbra to the shadow was most abrupt, and the edge of the shadow was very irregular. The decided darkening of the penumbra towards the shadow appeared very much later after contact with the penumbra than I have usually noticed it before.

The shadow was so dense and the gradation so abrupt that the rays on entering in were extinguished practically at once, and the elevated appearance of the rays was not seen except in the case of the two rays mentioned above and the slope east from Proclus.



Photograph of the Lunar Eclipse

taken by H. G. Tomkins, F.R.A.S.,
at Barrackpore, 17th Nov. 1910 at 16-22 St. Time.



HALLEY'S COMET

Photographed at Calcutta, on 28th May 1910
by
Mr. R. Taylor.

BY P. C. BOSE.

Place of observation—13-3, Chidam Mudi Lane, Calcutta.

Equipped with a telescope of $1\frac{1}{2}$ inches aperture, magnifying about 20 to 25 diameters and a watch which I knew kept pretty good time and which was corrected that day by the 1 o'clock gun, I waited for the predicted time when the Eclipse would commence. I must confess here that I could not rise in time to watch the penumbral contact. It was close upon 4-14 when suddenly I saw a smoky patch at the south-east edge of the Moon. The time then was between 4-$13\frac{1}{2}$ and 4-14 by my watch.

I took as points of observation Tycho, Copernicus, Aristarchus and the neighbouring regions and Proclus.

The following observations were made :—

At 4-14—The shadowed portion faintly visible.

At 4-24—A ruddy hue visible near the place of original contact.

At 4-27—Aristarchus and the surrounding regions disappeared.

At 4-56—Patches of light visible at Aristarchus.

At 5-4—The light becomes brighter.

At 5-6—The shadowed portion getting faintly illuminated.

At 5-12—A bright horn-shaped light of ruddy hue at the points is visible. Persisted till totality.

At 5-16—Nothing particularly visible about Proclus.

At 5-22—Nearing totality.

At 5-24—Lower portion of Moon invisible. Middle portion nearly so. Upper portion light fainter.

At 5-25—The upper portions faintly visible.

Further observation was rendered impossible owing to clouds near the horizon.

The shadow was of copper colour to the naked eye.

BY C. K. SARKAR, C.E., M.S.A., M.S.E.

A sketch of the Moon was prepared beforehand and was kept ready to enable me to note the progress of the shadow on the same. The edge of the sketch was darkened to enable me to see it clearly at night.

The exact time of contact could not be ascertained.

The edge of the shadow when it reached Copernicus seemed to spread out beyond the regular curve line near

about the region of that crater. Unfortunately I omitted to note the exact time when this happened.

The Appennine range continued bright along the ridge for a considerable period after the shadow had spread over the whole range.

Between 5-13 and 5-22 a.m. my attention was drawn to a particularly bright spot on the site of Aristarchus, by a friend who was observing with a 3½″ telescope. It looked like a bright speck, but was difficult to see with the 2″ terrestrial telescope I was using.

Some patches at the edge of the Moon seemed to be illuminated with a dull reddish light even, when the outer line of the shadow had passed beyond them.

At 5-26 a.m. totality commenced, but the margin of the Moon remained visible to the naked eye long after that till the break of day.

Instruments used—The observations were taken with a terrestrial telescope with 2″ object glass.

An astronomical telescope with 3½″ lens and eye-piece of 60 magnifying power was used to see the bright spots.

By T. S. Kochak.

The first appearance of the shadow was seen at 15-47.

No occultation of any star during totality was seen.

With the small telescope used magnifying to 7 diameters, nothing particular about light rays could be observed.

Aristarchus, Tycho and Grimaldi were kept specially under observation. In totality, Aristarchus and Tycho lost much of their shine, but remained comparatively brighter than other features. The streaks round Tycho could not be distinguished. Grimaldi, however, could be distinguished as a dark spot though the outlines became faded.

The colour of the Moon was a dirty yellow during totality. The colour on the side of the Moon towards which the shadow was progressing was the usual silver white. This faded and merged into dirty yellow ending at the other edge with a darker yellow. Why should there be this yellowish tint ?

The shadow appeared to slacken in speed to cross the edge distant from the side it entered.

Place of observation—Nawabgunge, Cawnpore.

Lat. N. 26° 25′ 8″.

Long. E. 80° 13′ 35″.

Sky—Clear.

Wind—Calm.

During totality one meteor from Andromeda was seen which passed right in front of the disc of the Moon to a very few degrees above the horizon. It was bright yellow followed by a quickly disappearing tint of bluish green colour.

BY NOGENDRA NATH DHAR.

1. *Place of observation*—Krishnagar City, District Nadia, Bengal.

2. Quite clear sky; no cloud or mist.

3. *Instrument used*—A Newtonian Reflector with 4-inch mirror made by Messrs. S. K. Dhar & Brothers of Hughli, Bengal. Power used was about 60.

4. *Progress of Eclipse*—

Contact with penumbra not observed.

Contact with shadow—a little to the south of east point at about 4-20 a.m.

Beginning of totality—about 5-30 a.m.

5. *Notable features*—

(*a*) Observation continued till shadow progressed for about a third of the Moon's disc. No occultation of stars noticed.

(*b*) Nothing particular was noticed regarding the rays radiating from craters during the aforesaid period of observation.

(*c*) One faintly luminous spot was noticed in the eclipsed part of the Moon at the spot known as Aristarchus.

(*d*) The edge of the shadow appeared to travel regularly as far as I watched the passage of the shadow; that is, till about a third of the Moon was eclipsed.

The Geminid Meteors.

BY THE DIRECTOR OF THE SECTION.

The next important meteoric shower is Geminids of 10th to 12th December. It is a rich annual shower of swift short meteors. As it is necessary for the persons observing it to make themselves acquainted with the constellation in which the radiant point is situated, a brief description of Gemini is now given. Many persons, I suppose, know the position of the bright fixed star Sirius in Canis Major called the

Dog-star. Indeed it is so very bright that even those who do not know it can find it without any trouble. It is the bright white star which is to be seen in the south-eastern sky at about 8 p.m., and it crosses the meridian of Calcutta a few minutes after 2 a.m., its zenith distance at that time being 39° towards south. At a short distance towards north and slightly towards east from this star will be found another very bright star, namely, Procyon (*i.e.*,) κ Canis Minoris, and north of Procyon will be found the two principal stars of the constellation Gemini, namely, Castor and Pollux (*i.e.*,) κ Geminorum and β Geminorum. Of these Pollux is brighter than Castor, their magnitudes being 1·2 and 2·0 respectively.

The R. A. and the declination of Castor are 7 hrs. 29 mts. and 32° 5′ N. On the 10th of December it will rise at Calcutta at 6-56 p.m. and its amplitude will be 35° 7′ (*i.e.*,) this will be its angular distance from the east point towards north. It will cross the meridian at 13-58 astronomical time which corresponds to the common time 1-58 a.m. of the 11th, and it shall be then 9° 32′ from the zenith towards north. South-west of Castor and Pollux is the small star ζ Geminorum; and then we come to three stars whose right ascensions are very nearly equal and therefore they are in a straight line running from north to south. Lastly, we come to the two small stars μ Geminorum and η Geminorum. The R. A. and the declination of the radiant point of the shower are 7-12 and 33°0N.-0 On the 10th of December it rises at Calcutta at 6-39 p.m. and its angular distance at that time from the east point shall be 36° 8′ towards north. It is very near Castor.

The November Meteors.

By B. N. Rakshit.

13th November 1910.

On the morning at 2-10 a.m. standard time the following Andromed meteor was observed.

Magnitude—1·5
Duration—2 seconds.
Characteristics—Slow, trains.

Direction.—If we join Aldibaran (α Tauri) with Capella (α Aurigæ), we find three small stars nearly equi-distant from each other. The direction of the meteor appeared to pass immediately above the first star from Capella and to

be nearly perpendicular to the above-mentioned line joining Capella and Aldibaran. It was from Andromeda towards the straight line.

Leonid Meteor—

At 3-21 a.m. standard time a swift meteor was observed, the direction of which if produced would pass near the west side of ε Leonis. It passed from north to south. The direction was judged from the line joining ε Leonis with the Pole star.

Duration—$\frac{4}{10}$th of a second.

Magnitude—About 3.

Note on a Large Meteorite.

By H. H. the Maharaja of Jalawar.

At quarter to 6 in the evening of the 24th November a very bright meteor was observed in the southern sky azimuth 200° (about). It moved slowly and disappeared after about a minute, but left a long streak of light (a nebulous or milky trail) in the air as well as a patch of luminous matter of about the size of a twelve inch Gramophone Record that remained suspended in the middle of the passage of the meteor, the streak continuing below it towards the earth. It marked the straight course of the meteor across the sky, but became curved after a few seconds. Both the patch and the streak remained visible for about 15 minutes, growing dimmer and dimmer all the time till they went out of sight altogether. The sky was quite clear and there was no wind.

I shall be very thankful if some person interested in meteors will throw light on the phenomenon and the cause of the patch remaining suspended in the air for such a long time.

[A similar bright meteor was seen at about the same hour on the 26th November at Beria in the Nimar District of the Central Provinces and reported to the *Pioneer* by Mr. C. F. Bell, Deputy Conservator of Forests. The tail remained visible for half an hour after the meteor disappeared. There was a loud report after the flash, and it was estimated that the meteorite struck the earth about 60 miles away. The object also appears to have been seen at Mhow and Bhopal. The explanation of these phenomena is given on page 6, the Journal of the Society, Vol. I, No. I H. G. T.]

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the Month of December 1910.

Sidereal time at 8 p.m.

	H.	M.	S.
December 1st	0	38	16
8th	1	5	52
15th	1	33	28
22nd	2	1	4
29th	2	28	40

From this table the constellations visible during the evenings of December can be ascertained by a reference to their position as given in a Star Atlas.

Phases of the Moon.

		H.	M.
December 2nd	New Moon . .	2	41 a.m.
10th	First Quarter . .	0	35 a.m.
16th	Full Moon . .	4	35 p.m.
23rd	Last Quarter . .	4	6 p.m.
31st	New Moon . .	9	51 p.m.

Meteors.

There is one important shower in December—the Geminids from the 10th to 12th.

Radiant point.		Character.
R. A.	Dec.	
7h. 12m.	+33°	Swift, short.

Other showers occur on 4th, 6th, 8th, 12th, 22nd, 25th and 31st December.

Planets.

Venus—Is an evening star still very close to the horizon at sunset.

Saturn—Is high in the sky at sunset and is now in the constellation of Cetus. On December 15th at 8 p.m. its

position will be R. A. 1 hr. 55 mts. 17 sec. and Dec. 9° 1′ 15″ N. Time of its setting 2 hrs. 14 mts. a.m. on the 16th December.

Mars—The position of this planet on December 15th at 8 p.m. will be R. A. 15 hrs. 37 mts. 20 sec. and Dec. 19° 14′ 0″ S. Time of its rising will be 4 hrs. 10 mts. a.m. on the 16th December.

Jupiter—On December 15th at 8 p.m. the position of Jupiter will be R. A. 14 hrs. 19 mts. 9 sec. and Dec. 12° 44′ 6′. The planet will rise at 2 hrs. 40 mts. a.m. on the 16th December and will therefore be an early morning object.

For the month of January 1911.

Sidereal time at 8 p.m.

	H.	M.	S.
January 1st	2	40	29
8th	3	8	5
15th	3	35	41
22nd	4	3	17
29th	4	30	53

From this table the constellations visible during the evenings of January can be ascertained by a reference to their position as given in a Star Atlas.

Phases of the Moon.

			H.	M.
January	*8th*	First Quarter	11	50 a.m.
	15th	Full Moon	3	56 a.m.
	22nd	Last Quarter	11	51 a.m.
	30th	New Moon	3	15 p.m.

Meteors.

There is one important shower in January—the Böotids of 2nd and 3rd.

Radiant point. R. A. Dec.	Character.
15h. 20m. + 53°	Swift, long paths.

Other showers occur on 3rd, 11th, 17th, 17th-23rd, 25th and 29th January.

Planets.

Venus—Is an evening star still close to the horizon at sunset.

Saturn—Is high in the sky at sunset and will be still in the constellation of Cetus. On January 15th at 8 p.m. its position will be R. A. 1 hr. 54 mts. 37 sec. and Dec. 9° 7′ 8″ N. Time of its setting 0 hr. 12 mts. a.m. on the 16th January.

Mars—The position of this planet on January 15th at 8 p.m. will be R. A. 17 hrs. 9 mts. 15 sec. and Dec. 23° 6′ 11″ S. Time of its rising will be 3 hrs. 48 mts. a.m. on the 16th January.

Jupiter—On January 15th at 8 p.m. the position of Jupiter will be R. A. 14 hrs. 38 mts. 4 sec. and Dec. 14° 12′ 19″ S. The planet will rise at 0 hr. 59 mts. a.m. on the 16th January.

Variable Stars.

The following variable stars may be observed :—

	R. A.		Dec.	
	H.	M.		
μ Cephei . .	21	40	+ 58°	16′
δ Cephei . . .	22	25	+ 57°	51′
° Ceti (Mira) . .	2	14	— 3°	9′
β Persei (Algol) .	3	1	+ 40°	32′

Extracts from Publications.

Mrs. Wilhelmina Fleming, who has just discovered a new star in Sagittarius, is attached to the Harvard University Observatory, and has for many years specialised in the detection of Stellæ Novæ. Like many eminent American Astronomers, Mrs. Fleming is a native of the British Isles, her birthplace being Dundee; but she has been at Harvard for thirty years and so long as 1887 made her first find of a new star. What the birth of this latest star can mean we are only faintly able to imagine; but the accepted theory regarding such phenomena is that two mighty suns which have cooled down to cold, dark bodies, but still rolling at incredible speed through space, now and again collide with terrific force. The impact generates such intense heat that the two dead stars, now united in one body, are raised to incandescence, and the new star we see is a mar of burning matter millions of miles in extent, and billion of miles distant.

[*English Mechanic.*]

The discovery of a new star in the constellation of Sagittarius has been announced by Mrs. Fleming, after an examination of the photographs taken at the Arequipa Observatory, but, remarks "P" in the *Manchester Guardian*, unfortunately the interest is somewhat diminished by the length of the interval that has elapsed between the photographic record of the star and its detection. The plate was exposed in May, and then the star was sufficiently bright to be seen with a small telescope. Its present magnitude is not stated; but since it is situated seven minutes west and three degrees north of γ Sagittarii, it is not now visible in these latitudes.

The collection of material of the photographic plate more rapidly than it can be discussed is not a new feature at Arequipa. On the occasion of the last discovery of a new star in Sagittarius, a whole year elapsed between the outburst of the announcement. The loss of possible interesting observations on its spectrum or change of magnitude is, of course, to be regretted; but it would be more regrettable if the resources of science were so feeble that they failed to give any record of the appearance of these unwonted phenomena. Such was the condition of astronomy before the invention of the sensitive dry plate. In the four centuries ending 1900, only 15 have appeared which might be regarded as Novæ. Of these no less than six were discovered since 1885. Of these six, five were detected by Mrs. Fleming from her detailed examination of Stellar Spectra. In general

they have been found not far from the Milky Way. Nova Coronæ, the first of the class to be examined spectroscopically, was remote from the galaxy; but the others have been sufficiently close to suggest some association with the main stream of the Milky Way, as the probability that such a distribution is due to accident is extremely small.

[*English Mechanic.*]

The passage of Halley's Comet, May 18th.

By Mr. Constoch.

At the Washburn Observatory, independent watches were kept by Mr. Flint and myself, on the night of May 18th, from early evening until the appearance of strong morning twilight without finding any indication of phenomena that could be attributed to the tail of Halley's Comet. A well marked auroral display was seen about 9 p.m. which subsequently disappeared and reappeared between 2 and 3 a.m. During the period last named, a vague band of light was faintly seen in the eastern sky presenting some resemblance to the zodical light, but too remote from the ecliptic to be identified. The night was clear, but the sky was slightly milky in appearance to such an extent that the galaxy, although distinctly visible, was inconspicuous even after the moon had set.

[*Popular Astronomy.*]

Meteors from Halley's Comet on May 6th.

By E. W. Abell.

Now that Halley's Comet has passed the earth without harm (at least to us), and is rapidly disappearing into the depths of space, not to return again, in the ordinary sense, for 76 years, it may be of interest to note that the earth was probably actually hit by fragments from the Comet on the morning of May 6th, and may continue to be so struck every year at the same date until the main body of the Comet again visits us 76 years hence. Thus it might be said that the Comet is always with us.

When observing the Comet, May 6th, at Folson Pa, near Philadelphia, about 3-30 a.m. I was impressed with the short flashes of several little shooting stars coming so close together that I remarked about them to my son Walter, whom I had awakened to see the Comet. They may have been 20 or 30 degrees to the right of the Comet, and somewhat higher, probably 30 or 40 degrees above the horizon.

One of them was quite large, probably of the 3rd or 4th magnitude and with a train 6 or 8 degrees long. Daylight began to be noticeable soon after. About 3-40 a.m., with the exception of the larger one, these shooting stars were small and exceedingly rapid. Their paths were short and downward. They were visible only for an instant.

[*Popular Astronomy.*]

The photograph of the spiral Nebula Messier, 64 Comæ Berenicis, is also most interesting, because this is the only spiral photographed in which the nebulous stars are present only in the central parts of the nebula, and are entirely absent in the outer convolutions. This is beautifully shown in the positive. In marked contrast to this are the spirals Messier 81, Ursæ Majoris, and the Great Nebula in Andromeda, in both of which the central regions contain no nebulous stars (so far as the 60-inch photograph can show), and in both of which the outer parts of the convolutions contain thousands of nebulous stars. In most of the large spirals, however, the nebulous stars are present in all parts of the convolutions from the central nucleus to the outer extremities.

[*Prof. Ritchie in Monthly Notices of the R. A. S.*]

The form of the Corona was fairly regular except at the S.-E. and N.-W. points, where the streamers occurred. The Corona was about half the Moon's diameter in length, and at a point between the vortex and the east point two well marked streamers, about one and a half times the Moon's diameter in length, flexing strongly to the east, were observable all through totality. The lower streamers were nearly opposite the upper ones, but were shorter, and not so well defined.

[*Monthly Notices of the R. A. S.*]

The New Astronomer Royal—His Majesty the King has been pleased to approve of the appointment of Mr. Frank Watson Dyson, F.R.S., Regius Professor of Astronomy in the University of Edinburgh, and Astronomer Royal for Scotland, to the position of Astronomer Royal in succession to Sir William Christie, K.C.B., F.R.S., who retires on the 1st of this month (October 1).

[*Observatory.*]

Notices of the Society.

The attention of members is invited to Bye-law No. 14. regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. A form of Application is enclosed with this number of the Journal. If a member wishes to propose a candidate, and does not know another member who will second him, the form should be filled up and signed by the proposing member, and should then be sent to the Secretary, Mr. P. N. Mukherjee, when the Council will be able to take action under the Bye-law above quoted.

The Library.

A subscription list for the founding of a Library has been opened, and members are invited to send in donations to meet the cost of buying books. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

Observing Sections.

Some members have begun to take up work, but Directors of Sections will be glad to receive names of others as soon as possible. If a member desires advice as to the direction in which he can do work of value with the means at his disposal, the President will be glad to assist him if written to.

Instruments.

Those who desire advice regarding the purchase of instruments should communicate at once with Mr. S. Woodhouse, who has on his list one or two second-hand instruments for sale, and is also in communication with a firm in England for their supply to members.

Subscriptions.

Members who have not yet done so are requested to remit their subscriptions to the Treasurer. Donations for the Library, or Quarters for the Society, will also be gladly received by him.

Meetings.

The Ordinary Meetings of the Society will be held on the following dates :—

1910.	1911.
December 21st.	March 28th.
1911.	April 25th.
January 31st.	May 30th.
February 28th.	June 27th

The Meetings will commence at 5 p.m., and until further notice will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

(2) *Secretary* (*Scientific*) . W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.

(3) *Do.* (*Business*) . P. N. MUKHERJEE, M.A., Imperial Secretariat Building, Calcutta.

(4) *Treasurer* . . . U. L. BANERJEE, Office of the Acct. General, Koila Ghat Street, Calcutta.

(5) *Librarian* . . . A. LAWRIE, 81, Middle Road, Barrackpore.

(6) *Editor* . . . J. J. MEIKLE, 8, Hastings Street, Calcutta.

(7) *Directors* :—

General Section . . DR. E. P. HARRISON, Presidency College, Calcutta.

Lunar Section . . REVD. J. MITCHELL, M.A., F.R.A.S., Wesleyan College, Bankura.

Meteor Section . . B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.

Variable Star Section . LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., United Service Club, Calcutta.

Photography . . R. J. WATSON, 37, Park Road, Barrackpore.

Instruments . . . S. WOODHOUSE, 1, Little Russell Street, Calcutta.

The Journal

of the

Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 3.

Report of the Meeting of the Astronomical Society held on Wednesday, the 21st December 1910.

H. G. TOMKINS, ESQ., F.R.A.S., *President*, in the Chair.
P. N. MUKHERJI, ESQ., M.A., F.S.S., *Secretary*.

The minutes of the previous meeting were read and confirmed.

It was then announced that the following members had presented donations to the Society to furnish a library and quarters :—

Library.

	Rs.
H. G. TOMKINS, ESQ., F.R.A.S. ...	75
N. VIJAYARAGHARAM	25
C. K. SARKAR, ESQ., C.E., M.S.A., M.S.E.	10
SARODA CHARAN MITRA, ESQ., M.A.B.L.	50
U. L. BANERJI, ESQ., M.A. ...	5

Quarters.

H. G. TOMKINS, ESQ., F.R.A.S. ...	75
P. C. BOSE, ESQ.	10

The thanks of the meeting were accorded to the donors.

The election by the Council of the following new members was confirmed :—

1. MAJOR T. R. MACLACHLAN.
2. CAPTAIN F. C. MOLESWORTH, R.E.
3. THE HON'BLE MR. J. S. MESTON, C.S.I., I.C.S.
4. J. MCCANN, ESQ.
5. ANATH NATH CHOWDHURI, ESQ., M.A.B.L.
6. COLONEL S. G. BURRARD, R.E., F.R.S.
7. JNANENDRA NATH GHOSE, ESQ., B.A.

The President next called on Mr. Rakshit to tell the meeting the results of the observation of the Geminid meteors.

Mr. Rakshit stated that he had received details of observations from several members, and that had not the moonlight interfered the display would probably have been a bright one. As it was, the observations pointed to the occurrence of the maximum of the shower in the early hours of the 12th December. Mr. Sitaramaiya of the Kodai Kanal Observatory had sent details of eleven meteors seen by him and another member, Mr. G. N. Mukherji, had also done the same and given the trails in a rough chart which he had made. The radiant was clearly traceable from many of them. Others who had seen the shower active were Mrs. Voigt and Mr. Connell. They had all seen them in the small hours of the morning, the early part of the night being barren.

Mr. Rakshit then gave the position and details of the next shower which was due on the 2nd and 3rd of January.

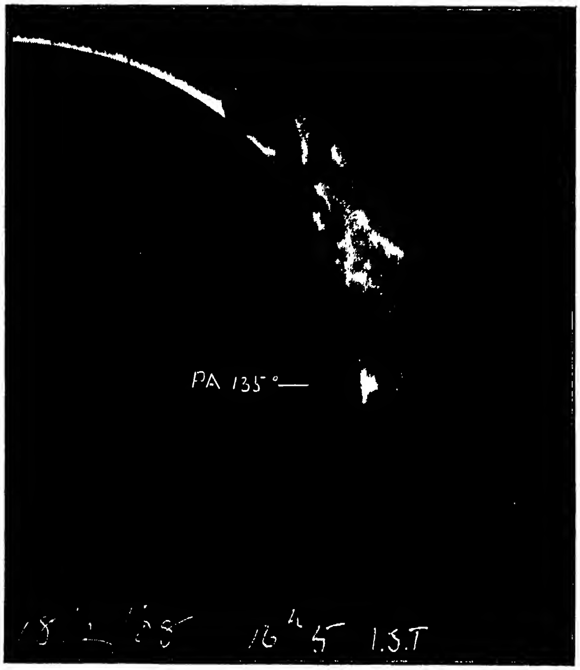
Dr. E. P. Harrison next read his paper on the tint of the moon when totally eclipsed, explaining it with the aid of a diagram thrown on the screen. Dr. Harrison stated that the paper had arisen out of the discussion at the previous meeting regarding the colour of the eclipsed moon, and he therefore put forward the explanation in more detail than was possible on the spur of the moment at the last meeting.

The thanks of the meeting were accorded to Dr. Harrison for his interesting paper.

Mr. Banerji then read a paper on the landscape which would be visible to an observer on the moon on the floor of the ring-plain Plato.

Mr. Banerji explained that he had been tempted to look into this matter on considering that were an observer actually on the surface of the moon, the scene around him would probably be very different from what we imagined when observing from the earth, in the same way as the terrestrial view would probably change considerably to the eye if we could observe it from the moon. Mr. Banerji then put diagrams on the screen which supported this conclusion, showing the effect that would be produced by placing the observer on different parts of the floor.

The President, in asking the meeting to accord their thanks to Mr. Banerji for his most interesting paper, remarked that Mr. Banerji had taken up a line of investigation which was well worth pursuing, as most observers who looked at the moon got into a habit of regarding the lunar features only as a whole, and often failed to appreciate what they would really look like if they were standing on the lunar surface. In



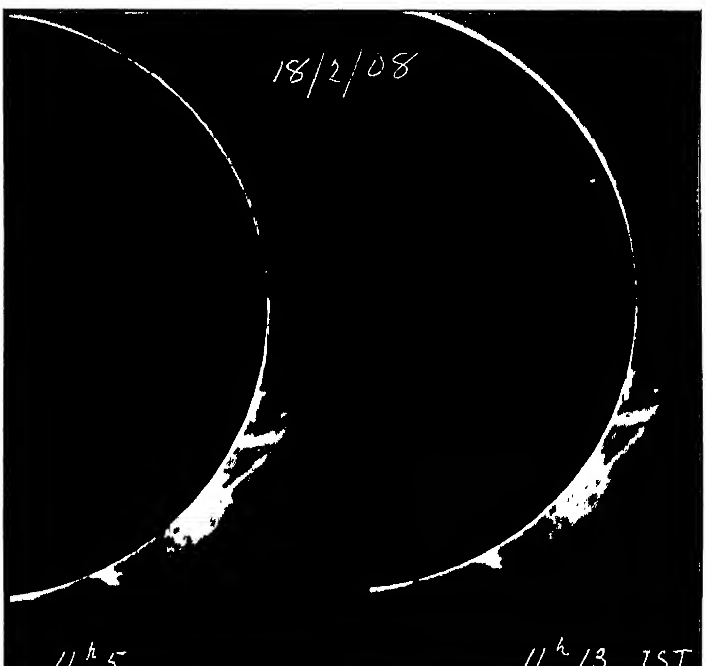


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911

Solar prominence photographed at the Kodai Kanal Observatory with the Spectroheliograph in the light of the calcium line K on the 18th Feb. 1908.

comparing what we saw there with what we experienced on the earth, this was most important, and it was to be hoped that Mr. Banerji would continue his investigations in the case of other formations on the moon.

Dr. E. P. Harrison, the Director of the General Section, then showed a series of slides kindly sent for exhibition by Mr. Evershed at the Kodai Kanal Observatory. In doing so, Dr. Harrison briefly explained the nature of the spectroheliograph with which instrument they were taken, and in showing the slides gave details regarding the nature of prominences. The photographs, he remarked, brought out very beautifully the extraordinary and rapid variations in the structure of the prominences.

The first four slides showed a large prominence taken on the 18th February 1908 which increased in size during the day and finally separated itself from the sun's limb, ascending into space with accelerating speed. When last photographed just before sunset, it was about 9′ or roughly 240,000 miles above the limb, and was moving away from the sun at the rate of over 50 miles a second.

Next came two photographs of a prominence taken on the 14th December 1908, showing vast changes in structure in the interval of an hour and a half; prominences taken on the 13th August 1908 showing a fine structure, another taken on the 23rd September 1909 of filamentary form, and then two magnificent pictures of jets over a large sunspot on the west limb. The last two, which were taken on the 7th January 1910, were also shown on an enlarged scale, which brought out excellently the details of their structures. Finally, two slides of spots and calcium flocculi were shown. These plates illustrated the tendency to form pairs of spots north and south of the Equator; they also showed well the fine structure all over the sun's disc.

The photographs were all taken at Kodai Kanal with the spectroheliograph in the light of the calcium line K.

The President remarked that the Society were fortunate in having these beautiful slides lent them from the Kodai Kanal Observatory. The work done there took its place with that of the great observatories of the world, and the observations were made by magnificent instruments in the hands of highly-trained men.

Hitherto very few of those who lived in India had enjoyed the chance of seeing any of the work done by professional observatories, but. as members were aware, the Director (Mr. Michie Smith) and Mr. Evershed had joined the Society and were good enough to lend t some of the photographs at

Kodai Kanal. The slides just shown, like those they had recently of Halley's Comet, were very fine specimens of what was turned out, and he thought members were to be congratulated on having obtained such an asset to their meetings and publications.

The thanks of the meeting were then accorded to Mr. Evershed with applause.

Mr. Woodhouse showed some photographs of the moon he had taken at the Presidency College, and drew special attention to one of his slides which had been made by means of the wet process. The slide possessed a fine rich tone which was much admired.

Mr. Woodhouse then read a short paper on the adjustments necessary for an equatorial telescope.

The thanks of the meeting were accorded to Mr. Woodhouse for his slides and paper.

The meeting was adjourned until the 31st January 1911 at 5 p.m.

The Crater Plato as viewed by an Observer on the Moon.

By U. L. Banerji.

The entire surface of the moon visible to us is covered by numerous mountains, ridges, plains and craters. The latter class consists of formations, which, when seen through telescopes of low magnifying power, appear like the craters of volcanos on our earth, although they are really diverse in character, the like of which can hardly be seen here. Astronomers divide them into different classes, *viz.*, walled plains, mountainous rings, ring planes, craters, crater plains, etc., according to the size and nature of these formations. Those belonging to walled plain class generally vary from 40 to 150 miles in diameter, surrounded not by a single wall but generally by an intricate system of mountainous ranges united together by cross walls. These mountains are again separated by valleys and covered by numerous ravines. Towards the exterior and interior of these walled plains can be seen several projections or arms extending in different directions. Sometimes these extending arms unite more than one walled plain and then terminate in lofty peaks, and sometimes extend to great distances as mountainous ranges. The inside of these walled plains is often level; sometimes crater cones or ridges are visible here and there, occasionally terminating in low mounds in the middle.

The surrounding walls of these walled plains are not uniform in character. They sometimes terminate in elevated mountains throwing long shadows on the plains during the lunation period, which vary in size with the altitude of the sun. Sometimes long ranges of comparatively low mountains interspersed by valleys run out to great distances in different directions. Sometimes these walls form the boundaries of tablelands, the craters forming in fact bowl-shaped depressions in these high elevated lands.

The Crater Plato, which is the subject of our study this evening, belongs to this walled plain class. It is situated at -10° Long. and $+50^\circ$ Lat. On one side of it is Mare Imbrium, while on the other is Frigoris. Its diameter is about 60 miles. Its surrounding walls or ramparts, so to say, vary from 3,000 to 3,800 feet in height, the highest part (3,800 feet) being on the east, while the lowest part (3,000 feet) on the south. Beyond the walls on the east is the loftiest peak ξ 7,418 feet high, while on its opposite on the west are visible 3 lofty peaks γ, δ and ϵ, 7,238, 6,369, and 5, 128 feet high respectively. These peaks form the extremities of a series of mountainous ranges, which slope down from the walls all round, specially on the south-west, which forms a great belt of tableland covered by numerous hills and ridges. On the east is also a tableland sloping down from the peak ξ forming the southern part of the Mare Imbrium. This whole system of tableland carrying Plato in the middle separates Frigoris from Mare Imbrium, and ultimately terminate in the Alpine ranges on the west.

The floor of Plato is of dark steel colour which undergoes change with the elevation of the sun. Viewed on the 15th December 1910, 3 days before the full moon, it seemed dark grey in colour. There were also visible some light grey streaks and 2 or 3 small white round spots. Astronomers discovered that these spots form crater cones with bright steep exterior walls, and a minute central crater on the summit. These streaks are rather brighter near the border and close to these white spots.

Let us now consider what view these surrounding walls and peaks will give to an observer situated at different places of Plato's surface. It being like a plate with high borders, it may naturally seem that an observer standing in the centre will see the *entire* walls with peaks projecting over it, and it might be thought that he would realise himself to be inside a flat-bottomed bowl. But this is not so; the curvature of the moon's surface makes a great difference. It will obstruct the lower part of the walls, and the further he moves way from each wall, the greater will be the portion of the wall disappearing from his sight.

Taking the radius of the moon as γ miles, α the distance of the observer from the wall in miles and h the height of the wall in feet invisible to him, we may find out the value of h geometrically in terms of γ and α thus :—

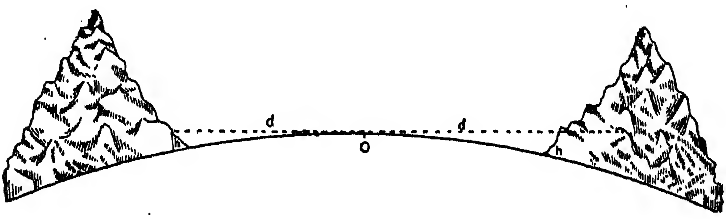
$$\frac{h}{1760\times3}\left(\frac{h}{1760\times3}+2\,r\right) = d^2$$

Now the radius of the moon as 1,080 miles, so we get

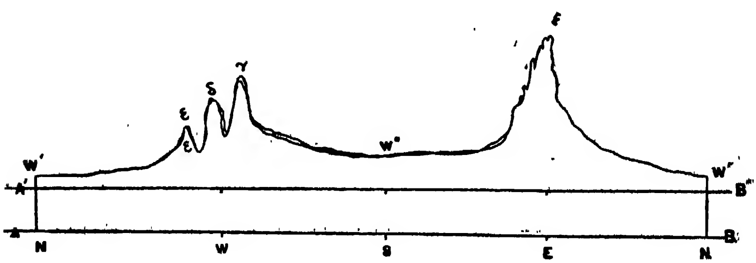
$$\frac{h}{1760\times3}\left(\frac{h}{1760\times3}+2160\right)= d^2$$

$$\text{or } h = 2{\cdot}44\, d^2$$

Now if the observer stands at the centre, the walls would be about 30 miles distant from him. The value of h would then be 2,176 or say 2,200 feet, that is, in other words, he will not see 2,200 feet of the walls from the ground and the walls around will appear to him as only 800 to 1,600 feet high. If the crater is divided by a plane perpendicularly passing through the centre, the portion seen will be above the dotted line. The portion of the walls below the dotted line will not be visible to him.

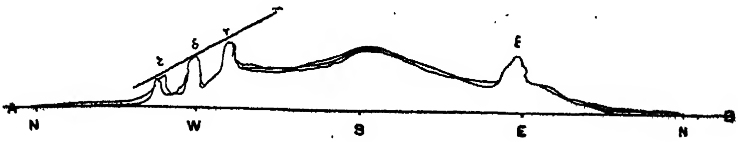


Spreading out the surrounding walls in a straight line its height at different places and the heights of the peaks beyond may be graphically shown thus :—



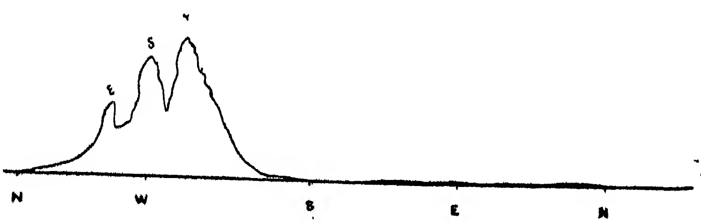
A B is the plane or crater.
W′ W″ W′ is the wall spread out in a line.
A A′ and B B′ =22,000 feet obstructed from his view.
The observer will only see A′W′ to B″W″ portion and the peaks above.

If he moves towards the south wall he will gradually have the full view of it, while the walls on the north at his back and those on his sides at the east and west will gradually disappear and their peaks only be visible. The view of the walls may be graphically shown as below :—



Here the mountain peaks will appear to him nearly of the same height as the wall before him, although they are higher than the walls at their feet, while no portion of the wall on the north will be visible to him. He will only see the flat bottom of the crater in that direction.

If he now moves to the west wall only the 3 peaks, ϵ δ and γ and the walls below will come full into his view, while the walls on the north and south, as well as the highest peak ξ on the east, will disappear altogether. The view will be as below :—



The same thing will happen if he goes to the east wall.

If he moves to the north wall at last he will have the view of other walls as below :—

Thus if he moves about from place to place within the crater, the walls on one side will come to his view, while those on the other will appear lower and lower and then disappear below the horizon, and he will hardly imagine that he is within a bowl-shaped enclosure surrounded by a wall.

Had the crater been upon the earth, whose curvature is not so large, only about 600 feet (instead of 2,200 feet) of the walls would have been invisible to him from his position at the centre. Standing at the extreme ends he would have a gradually sloping view of the walls, which would just become invisible at the opposite end.

Illumination of the Moon's Disc during a Total Lunar Eclipse.

BY DR. E. P. HARRISON.

The following short note has arisen out of a discussion which occurred after the last meeting of the Society. It was subsequently thought that a few remarks on the subject of the illumination seen over the moon's disc during a total eclipse might not be without interest to some of the members. The usual diagrams given in text-books of a total Eclipse of the moon make clear the state of affairs during a total eclipse. They show the arrangement of the three bodies involved, and indicate the extent of the shadow when the earth is considered to possess no atmosphere. It is seen that the moon is completely in shadow, and apart from resultant illumination due to starlight, should be invisible from the earth.

The "radius of the shadow" may especially be noticed as being an important factor in the determination of the length of an eclipse. Its maximum value in any possible eclipse is $1° 2'$ of arc.

Now suppose that, by some means or another, a portion of the light of the sun as it passes immediately over the earth's surface is bent inwards towards the centre of the moon, the effect is obviously that a certain amount of illumination is shed over the eclipsed disc, rendering the latter visible from the earth.

The existence of our atmosphere supplies us with a cause for the necessary bending, and consequently, with a perfectly satisfactory reason for the illumination observed during totality. It is only necessary now to calculate the *amount* of the refraction produced by the layer of air over

the earth's surface, and to see whether the bending is sufficiently great to account for the illumination of the whole of the moon's disc.

The problem is similar to that of finding the difference between the times of real and apparent sunset.

Suppose a sunset is observed at the time of an equinox on a clear still day at sea. In actual fact the sun is below the horizon about 2 minutes and 12 seconds before it is *observed* to disappear. In other words, if the atmosphere were suddenly abolished at the moment the sun's lower limb appeared to touch the sea, darkness would be instantaneous. The fact that sunlight still reaches us after the sun is geometrically out of sight is due to this same refraction by the air, which enables the illumination of the moon's disc during an eclipse to be accounted for.

The amount of the bending will depend on the angle at which the light enters the atmosphere, and can best be calculated by experimental methods. Observations on the zenith distance of a circumpolar star at its two culminations will yield a value for the amount of refraction by the air corresponding to a particular altitude, and its value can be found by this and other methods for any altitude from 0° to 90°. At 90°, when the body observed is in the zenith, the refraction is, of course, zero; it is at maximum when the light reaches the earth's atmosphere at grazing incidence, that is, when the altitude is 0°. This last is clearly the particular value of the refraction which we need in the eclipse problem. It is called the "Mean Horizontal Refraction," and its value is 33 minutes of arc for air at 50° F. and at a pressure corresponding to 29·6 inches of mercury.

Now, in the actual case before us, the sunlight will be refracted twice: once on entering the atmosphere, and once on leaving it, so that the total angle through which the light is deflected is *twice* the horizontal refraction, or 66 minutes, that is, 1° 6′. But the maximum "radius of the shadow" is, as we have seen, 1° 2′, so that the light refracted by the earth's atmosphere easily covers the whole of the moon's disc even in the case of a perfectly "central" eclipse.

The faint illumination observed during a total eclipse is thus accounted for. There remains the discussion of the colour of that illumination.

A Principle in Optics known as Diffraction provides the required explanation.

In the first place, it must be remembered that the light from the sun is composite. It may be described as consisting of a series of waves in the ether varying in length from

$\frac{1}{1400}$th of a millimeter which give the sensation of red light, to $\frac{1}{2500}$th of a millimeter, which give a sensation of blue.

This composite light passes through the atmosphere and becomes modified during its passage in the following way: There exist, floating in the air, a multitude of particles so small that their diameter is comparable with the length of the shorter or blue waves. These particles are in the direct path of any beam of light which enters our atmosphere, and the principle of diffraction indicates that when a beam of white light enters such a turbid medium, the short blue waves are irregularly reflected by the little particles (thus giving rise to the blue colour of the sky which is almost entirely due to this reflected light), while the longer red waves pass on unscattered.

Evidently, if the beam of light passes through a sufficiently thick layer of air, it will eventually be robbed of its blue constituents and will become correspondingly rich in reds and yellows. This is, indeed, precisely the effect observed at sunset and sunrise; when the sun's altitude is small, his light has to pass through a greater thickness of air than it does when he is in the zenith; consequently sunset tints are yellow and red. The blues have been filtered out during transmission.

For the same reason the snow of a distant peak appears yellowish in tint, and the spectrum of the earth-shine on the moon near to the time of new moon is poor in blues.

If we apply this reasoning to the problem of the eclipse, it is evident that the refracted light, having passed through a great thickness of air, will be tinged red, and that consequently, if no change in the character of the light occurs on reflection from the moon's surface, we should expect to see what we actually *do* see, that the faint illumination of the moon's disc during an eclipse is of a distinctly reddish hue.

Finally, it is interesting to try to account for the different intensity of illumination observed in different eclipses.

Observers have continually noted this variation in intensity from one eclipse to another. Indeed, in the eclipse of 1886, the moon's disc was said to have been absolutely invisible.

Probably the effect can be accounted for by assuming the existence of clouds round a large portion of the ring of air which forms the refracting medium during an eclipse. In the 1886 eclipse, a very large proportion of this ring must have been cloud-laden at the time, almost completely shutting off the refracted sunlight and giving rise to an absolute eclipse of the kind which would occur were there no atmosphere at all.

The explanation just given suggests that the intensity of illumination during an eclipse may possibly vary with the time of year ; for example, it might be suspected that in June, during the beginning of the monsoon, when masses of vapour are pouring northwards from the equator, the eclipse-glow would be somewhat reduced in intensity. Moreover, since the reduction in intensity would occur principally in the plane of the earth's equator, we might expect to notice a belt of relatively faint illumination stretching across a plane parallel to this on the moon's disc.

Differences in appearance and intensity of the illumination during any one particular eclipse are most likely due to absorption of light by the layer of air *through* which we see the phenomenon of the eclipse. In Bankura, for example, a brighter illumination of the disc would be expected than that observed in Calcutta, where the air is less pure.

One more point is, I think, of interest.

The amount of refraction by those portions of air near the poles of the earth is greater than that by portions of air near the equator, owing to a difference in temperature between these regions. The Mean Horizontal Refraction for air at 50° F. and 29·6 ins. pressure is, as has been mentioned, 33 minutes of arc. The Horizontal Refraction of air at the same pressure and a temperature of 20° F. is about 40 minutes of arc. So there is a difference of 7 minutes in the amount of refraction in two planes at right angles ; thus, theoretically, at all events, there should exist a short straight belt on the moon's surface parallel to the earth's polar axis which is more brightly illuminated than the rest of the disc. An observer standing anywhere on that line on the moon would observe the rim of light round the edge of the earth to be brighter there than at any other station on the satellite.

In subsequent eclipses it would perhaps be worth while for observers to look out for any indication of a relatively bright band near the centre of the disc.

Photographs of the eclipse would be most likely to show the effect, if it is to be seen at all.

Meteor Observations—The Geminids.

REPORT BY THE DIRECTOR.

The Geminid shower of meteors was fairly well observed by several members in spite of the moonlight which interfered with observations in the early part of the night. One meteor was observed on the 11th December at 4 hrs. 36 mts. a.m. (S.T.) the duration of which was about half a second and the magnitude 3. On the 12th he saw three others between 4 hrs. 26 mts. and 4 hrs. 36 mts. They were obviously Geminids, swift and short.

Mrs. E. Voigt observed eight meteors of the last Geminid shower within a short time after 3 a.m. on the 12th December. Of these, three were as bright as a star of 1st magnitude and the others were of 3rd and 4th magnitudes. The first five followed each other at short intervals and then after a time the other three came at longer intervals. Their duration was about a second and they all fell from west to east. One seemed to start from 22 Monoceros, another from Procyon and another from Hydræ. The rest seemed to come from the direction of Castor.

Messrs. S. Woodhouse and H. Connell observed at 7 p.m. on the 8th December from the Presidency College, Calcutta, one very short swift meteor having its radiant point near Castor. This evidently was one of the Geminids.

On the 5th December between 9 hrs. 50 mts. and 11 hrs. p.m. they observed from the same place several fine meteors. These appeared to come from Perseus and travelled right across the zenith through Andromeda down towards the western horizon. One of these was particularly beautiful. It split, and the two halves finished their flight in two different directions. At 10 hrs. 45 mts. p.m. another noteworthy meteor came from Capella (*i.e.,*) α Aurigæ travelled south of Cassiopeia down in a north-westernly line. The atmosphere was not very clear.

Mr. G. N. Mukherji of No. 7, Dr. Durga Charan Banerjee Road, Calcutta, took a series of meteor observations of the last Geminid shower on the 11th December from 2 hrs. 55 mts. to 4 hrs. 30 mts. a.m. He observed eight meteors from 2 hrs. 55 mts. to 3 hrs. 30 mts. five from 3 hrs. 31 mts. to 4 hrs. 0 mts. and six from 4 hrs. 1 mt. to 4 hrs. 30 mts. a.m. He states that the colour of the meteors was white and the atmosphere was clear.

Mr. S. Sitaramaiya of the Kodai Kanal Observatory also took observations of meteors of the last Geminid shower. The following are the results :—

Date and period of watch.	Serial No.	Time.	Length.	Brightness.	REMARKS.
		H. M.	°		
December 10th, 4h.-30m. to 5h.-30m.	1	5—21	2	Very faint.	The time used is Indian standard time. Thin cloud on the western sky on the 10th ; and the sky was clear on 11th and 12th during observation.
December 11th, 4h.-45m. to 5h.-30m.	1	5— 1	2	Do.	
	2	5—11	6	Do.	
	3	5—14	2	Faint.	
	4	5—23	2	Very faint.	
December 12th, 4h.-20m. to 5h.-30m.	1	4—39	8	Faint.	
	2	4—40	9	Do.	
	3	4—43	6	Do.	
	4	4—45	4	Very faint.	
	5	4—52	5	Faint.	
	6	5—11	5	Bright, mag. ±.2	

Extracts from Publications.

Dr. Crommelin, at the Meeting of the British Astronomical Association held on the 30th November 1910, speaking in connection with Halley's Comet, said that Mr. Beattie (one of the observers) drew the conclusion that the Earth did not pass through the tail, but he (the speaker) would not like to pronounce positively on that. It was pretty clear that they did not go through the immense long streamer which all the observers had described in such glowing terms : that was seen in the morning sky at the time of transit, and for two or three days after. It was a puzzle to him how that beam went on so long in the eastern sky, when the Comet itself was in the west. Mr. Innes made the suggestion that when the tail got near the Earth, the Earth expelled it ; that the Earth had the same repulsive power as the Sun, and turned away the tail, so that they did not go through it. It was a pretty theory, but he could not altogether accept it. It seemed to him that if the Earth had any power of the kind, it could only act on tail matter extremely near it, and he did not see how it could push out the whole of that immense beam, the head being 12 million miles away. It did seem to him, however, as if the great beam was detached from the head before it passed in the neighbourhood of the Earth. But underneath this great beam, Professor Barnard drew a broad shade of faintly luminous matter, very much like what was described of the Comet

of 1901. That also had a narrow, pretty straight, bright tail, and a broad fan-shaped, faint one. He thought it was probable that they did go through that faint appendage. There was no doubt they went sufficiently near the bright tail to bring them within the faint appendage if it persisted till the Earth reached it. It was seen some days before the Earth came up to it, and if it persisted until the Earth arrived, they could not miss it. There were a number of atmospheric effects in various parts of the world about the time they would have been on that tail, and whilst no one of these was in itself conclusive, yet the combination of them made a strong case for our having gone through some of the tail matter. There was the luminous appearance of the clouds, the so-called lunar corona and curious bands of light in various parts of the sky, which might all have arisen from the presence of unwonted matter in the atmosphere. As regarded the magnitude of the nucleus, from many observations the general consensus of opinion was that its greatest brightness was that of about the second magnitude. They might have seen in the Astrophysical Journal the observations taken with the new Selenium photometer, which made the greatest brightness about the second magnitude. This instrument was so sensitive that a secondary minimum of Algol was detected, owing to the occultation of the fainter star by the brighter.

[*Journal of the British Astro. Assocn.*]

The following method of obtaining roughly the heliographic longitudes and latitudes of spots and faculæ on the Sun, and computing their areas, is given by Mr. Maunder, Director of the Solar Section of the British Astronomical Association, and may be useful to members of the Astronomical Society of India in connection with Dr. Harrison's outline of work given in the last numbers of the Journal.

Mount a piece of millimetre-scale paper behind the telescope so as to receive the projected image of the Sun. The scale paper should be square, and 200 millimetres in length of side, and it should be fixed at such a distance that the Sun's image just touches the four sides of the square. The vertical line through the centre of the square, and also the horizontal line through that centre, should be inked-in distinctly, thus dividing the square into four smaller squares, each 100 millimetres in side, and when the scale paper is properly adjusted, the image of the Sun will be divided into four quadrants. If we call the distance of a spot from the

vertical central line as X, + from the horizontal central line as Y, then the position of a spot will be indicated by simply reading it off from the scale paper, taking X as + when the spot is E of the vertical, or, more properly, the N.-S line, and Y as + when it is N. of the horizontal or E.-W line; so that—64 X + 16 Y would indicate a spot in the N.-W. quadrant 64 millimetres W. of the N.-S. line through the centre, and 16 millimetres N. of the E.-W. line. The number of square millimetres covered by the spot would express its area. The particulars would enable the spot observed to be identified; and the Director would convert the numbers thus obtained into heliographic latitude and longitude and millionths of the area of the Sun's visible hemisphere. The time of the observation must be carefully noted.

[*Journal of the British Astro. Assocn.*]

Mr. Goodacre writing to the *English Mechanic* says: "Observers of Aristararchus should always be on the look-out for the appearance of a bluish light enveloping the walls. This phenomenon has been seen by several observers, including myself and Major Molesworth. The latter also on one occasion (1897, Sept. 21st), near sunset, when ring was filled with shadow as far as W. wall, saw the central mountain and the terraces on the inner slope of the E. wall faintly visible through the shadow, as if illuminated by phosphorescence or by a light reflected from the W. wall—a remarkable and unique observation."

[*English Mechanic.*]

Mr. Edwin Holmes, writing to the *English Mechanic* in connection with Saturn's rings, says: "Proctor has dealt with the various changes of appearance the rings would present from Saturn, but treated the matter as if they were continuous surfaces. He mentions that although the satellites would, some of them, appear as full Moons, and some as crescent, this would not affect the apparent brightness of the various regions, because mutual eclipses and occultations would balance the effects due to the phases," in which I humbly submit he was in error, unless he assumes that they are so closely packed as to present a continuous surface even to an observer on Saturn. As the distance from the surface of Saturn is, from the nearest ones, only one-eighth of the distance of our Moon from the Earth, and the diameter at 50 miles, each about one-fiftieth of our Moon, they would exhibit a disc one-sixth of that of our Moon, decreasing, of

course, according to positions and distances, but, if separated by their own diameters, quite separately visible. Of course, there is no absolute evidence that the moonlets are any bigger than cricket-balls; but what a countless number would then be required to form such a gigantic ring; and unless we suppose them so close together that only a portion of each moonlet situated above or below the common orbit plane can receive any light from the Sun, it appears to me that crescents should be visible to Saturnians situated to view the dark sides of their globes.

What a task for Saturnian Astronomers, if there existed such, to identify these hundreds of thousands or hundreds of millions of Moons—to follow them in their sinuous, ever-changing paths, and to calculate their eclipses and occultations! What a miracle these rings are!

[*English Mechanic.*]

Mr. A. S. Eddington in an introduction to his paper on the Systematic Motions of the Stars of Professor Boss's Preliminary General Catalogue says:—

"The main purpose of the present investigation was to determine as accurately as possible the directions, velocities, and relative proportions of the two star-drifts. The work was arranged for the purpose of developing rather than demonstrating the theory. But I shall also endeavour to exhibit the strong indications of the two streams as they appeared in the course of the work. In this connection, it may be well to define exactly how much is claimed for the two-drift* theory. The existence of two streams of Stars appears to me beyond doubt: that is to say, there are two favoured directions of motion in which the Stars appear to stream; this peculiarity is substantially the same in all parts of the sky, and it is by far the most noteworthy feature in the distribution of the stiller motions. In the light of Professor Dyson's researches on the very large proper motions, I do not see how this conclusion is to be avoided, unless we suppose that even the largest and best determined proper motions are altogether unreliable. When, however, this phenomenon is expressed as a quantitative law, and the amount of the streaming is measured, some approximation is necessary. Two forms of mathematical approximation have been used, namely, the two-drift hypothesis (which may be regarded quite apart from the tempting inference that the Stars belong to two intermingled, but originally separate, systems), and Professor Schwarzschild's ellipsoidal hypothesis. Working on either of these theories, it has been

found possible to construct an ideal representation of the universe of a fairly simple character, which will summarise quantitatively as well as qualitatively the most significant features of the arrangement of stiller motions. But such an ideal representation is essentially an approximation; it must be our object, as we obtain improved data, to discover what modification may be indicated, and thus to proceed to a closer approximation. Undoubtedly a complete account of the stiller motions will need to take account of the spectral types of the Stars, for there is considerable evidence of a connection between spectral type and linear motion; up to the present it has not been possible to take this heterogeneity into account. Realising, then, that the two-drift theory is to be regarded only as a first approximation, it is claimed that it yields a close approximation, perhaps as close as can be attained in the present state of our knowledge of stiller motions (see, however, § 6). Further, it correlates for us the distributions of motion observed in different parts of the sky, and shows that they are all essentially the same phenomenon, seen under different aspects.

[*Monthly Notices of the R. A. S.*]

* It is convenient to use the word *stream* for a general tendency of the Stars to move in a favoured direction, without implying any hypothesis as to the cause or exact distribution of the motions; the word *drift* is used to denote a system having a distribution of individual velocities according to Maxwell's law.

Addresses of Officers.

(1) *President* . . .	H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.
(2) *Secretary (Scientific)* .	W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.
(3) *Do.* (*Business*) .	P. N. MUKHERJEE, M.A., Imperial Secretariat Building, Calcutta.
(4) *Treasurer* . . .	U. L. BANERJEE, Office of the Acct. General, Koila Ghat Street, Calcutta.
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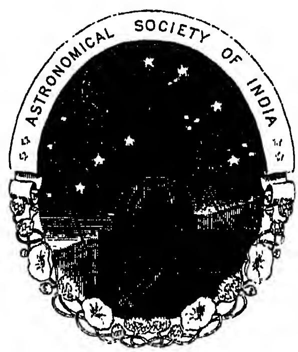
(6) *Editor* . . .	J. J. MEIKLE, 8, Hastings Street, Calcutta.
(7) *Directors*:—	
General Section . .	DR. E. P. HARRISON, Presidency College, Calcutta.
Lunar Section . .	REVD. J. MITCHELL, M.A., F.R.A.S., Wesleyan College, Bankura.
Meteor Section . .	B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.
Variable Star Section .	LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., United Service Club, Calcutta.
Photography . .	R. J. WATSON, 37, Park Road, Barrackpore.
Instruments . . .	S. WOODHOUSE, 1, Little Russell Street, Calcutta.



A Common Seal
for
The Astronomical Society of India
Designed and Engraved by Mr. F. C. Scallan
and accepted by the Council.

ERRATUM.

On page 90 of JOURNAL, Vol. I, No. 4, from the 7th line from the top, strike out the words "one of," and in the 8th line *read* the word 'are' for 'is.'

The Journal

of the

Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 4.

Report of Meeting of the Society held on Tuesday, the 31st January 1911.

H. G. TOMKINS, F.R.A.S., *President, in the Chair.*
P. N. MUKHERJI, M.A., F.S.S., *Secretary.*

The Monthly Meeting of the Astronomical Society of India was held in the Imperial Secretariat Buildings (ground floor) on Tuesday, the 31st January 1911, at 5 p.m.

The meeting was opened by the President, and after the minutes of the previous meeting had been confirmed, several new members were enrolled. The President then announced that the Comptroller-General had kindly placed a rent-free room with a small verandah in the Secretariat Buildings at the disposal of the Society, where the Library and Reading-room would be located, and a vote of thanks to the Comptroller-General was carried with applause. It was then announced that a special General Meeting would be held at 4-45 P.M., just before the next ordinary Monthly Meeting on the 28th February, to pass Bye-laws for the regulation of the Library and to amend certain other Bye-laws. The President then remarked that two suggestions had recently been made to the Council, who had accepted both: the first in connection with four in-door and out-door classes to be held for beginners by Mr. Rakshit, the dates and places to be notified later; the second that the Society should arrange for a course of free lectures to be held in the Town Hall, which the public would be welcome to attend. Details of these lectures would be issued later,

The election of the following members was then confirmed:—

1. SUDHINDRA NATH BASU, ESQ., B.A.
2. RAJ CHANDRA CHANDRA, ESQ., M.A.
3. DR. PROMOTHA NATH NANDI, L.M.S.
4. G. LEATHEM, ESQ., I.C.S.
5. NARENDRA NATH BASU, ESQ.
6. DINA NATH DUTT, ESQ., M.A.
7. N. N. BLOMEFIELD, ESQ.
8. BEPIN BEHARI BASU, ESQ.
9. KRISHNA CHANDRA DEY, ESQ.
10. HARAN CHANDRA BANERJEA, ESQ., M.A., B.L.
11. RAJA SREE RAJA A. V. JUGGA RAO BAHADARU GARU, F.R.A.S., F.R.MET.S., F.R.C.I., F.M.U., F.A.S., ETC.
12. A. N. METTAM, ESQ.
13. MRS. F. C. SMALLWOOD.
14. JATINDRA NATH MUKHERJEA, ESQ.
15. ROMA PROSAD ROY, ESQ., B.A.
16. S. J. KNOLLES, ESQ.
17. HARI SADHAN MUKHERJEA, ESQ., M.A.
18. R. H. D. LACEY, ESQ.
19. A. K. TAYLOR, ESQ.

Mr. Rakshit, Director of the Meteor Section, read a note kindly sent in by His Highness the Maharajah of Jalawar on a brilliant Meteorite observed, and also gave the result of the Meteor observations of the Section.

The President, in returning thanks to Mr. Rakshit and the Maharajah of Jalawar, remarked that the Society had certainly secured a very energetic member in His Highness, this being the second paper of its kind contributed by him. He had evidently taken some pains and trouble over the calculations of distances in the paper, which were extremely interesting, and supported also by Mr. Rakshit's figures.

Mr. Holmes.—I should just like to ask one question about Meteors. Some time ago, about a month, I noticed a photograph of the course of a Meteor in the *Times of India*; I have not the photograph with me, but have written to the Editor to ask whether he will be willing to let me see and have the use of the plate. This picture showed the path of the Meteor as being zig-zag. I should like to know if anybody has studied this. I have always been under the impression that the path of a Meteor would be straight, but this one zig-zagged very much like a flash of lightning.

The President.—I took a photograph of one of the Leonid Meteors of 1899, and on examining the result closely, I found a dark line coursed down the streak, and the latter was fairly straight. Perhaps Dr. Harrison could tell us whether the conditions of the atmosphere had anything to do with the zig-zag appearance noticed by Mr. Holmes.

Dr. Harrison.—The only thing that occurs to me is that it might possibly be accounted for by explosions or the bursting of the Meteor, which might result in this zig-zag effect on the photograph.

The President.—We shall be very pleased to receive and shall look forward to getting Mr. Holmes's contribution on this interesting point.

Lieut-Colonel Lenox Conyngham, Director of the Variable Star Section, next showed a lantern picture of the

Common Seal of the Society which had been accepted by the Council. The design was approved with applause. He then went on to read a very interesting paper on the Variability of Stars, fully illustrating his remarks by lantern slide pictures and blackboard drawings.

The President.—In thanking Colonel Conyngham for his very interesting paper, I think that we shall look forward with great interest to the reading of this paper in the JOURNAL, as Colonel Conyngham has no doubt given us a great deal to think of. There is just one point I would like to notice. I have it in my recollection that about six months ago I saw that photographs of the Algol curve had been taken showing a slight secondary minimum.

Lieut-Colonel Conyngham.—Do you refer to a secondary minimum in between two maxima?

The President.—That was my impression. It was quite a recent discovery made on examination of photographs as far as I remember.

Mr. Banerjee next read an interesting paper on the Crater of Clavius, fully explaining and illustrating his discourse with lantern slides.

The President. in returning thanks to Mr. Banerjee, remarked that this was the second of Mr. Banerjee's papers on a similar subject, and that all would agree with him that Mr. Banerjee had treated the Craters in a very able and graphic way, showing exactly what they would look like if one were to stand in the middle; and he had also made a new departure in showing what would be the scene from the tops of the peaks of the mountains.

Lieut-Colonel Conyngham now took the Chair while the President read a paper on the Systematic Motions of the Stars.

Lieut-Colonel Conyngham, in returning thanks to the President for his paper on the researches into the stellar motions, remarked that the President had very ably picked out just those points which were of most importance and interest in a very broad and comprehensive subject.

Mr. Pearce, a representative of Messrs. Watson & Co., London, next demonstrated and explained the use of certain telescopes, cameras and instruments for use in Astronomical work which his firm had sent out specially on account of the Society to fill the requirements of any of the members.

A vote of thanks to Mr. Pearce was returned, and the Meeting was then adjourned to the 28th February 1911.

The Variability of Stars.

BY LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S.

It has occurred to me that it may be of interest to those members who are taking up the observation of variable stars to hear a short account of the way in which the observations are used in deducing the cause of the variations from the light curves. I shall confine myself to stars of the Algol type.

fig. 1

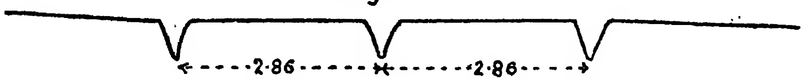
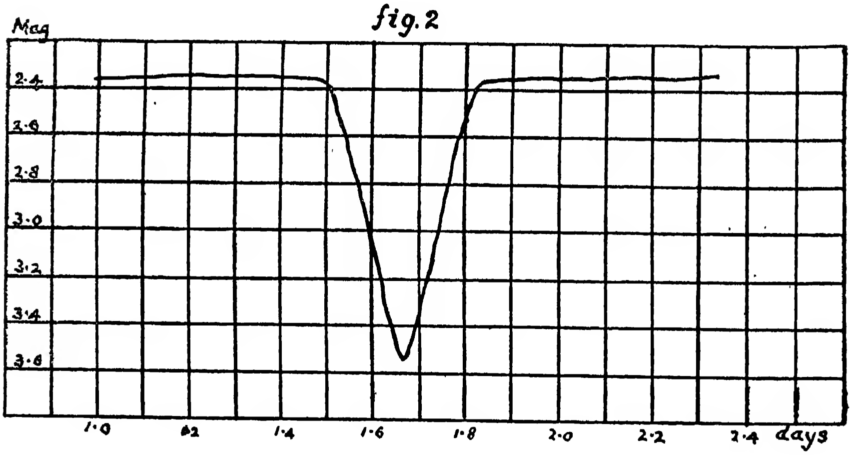


fig. 2

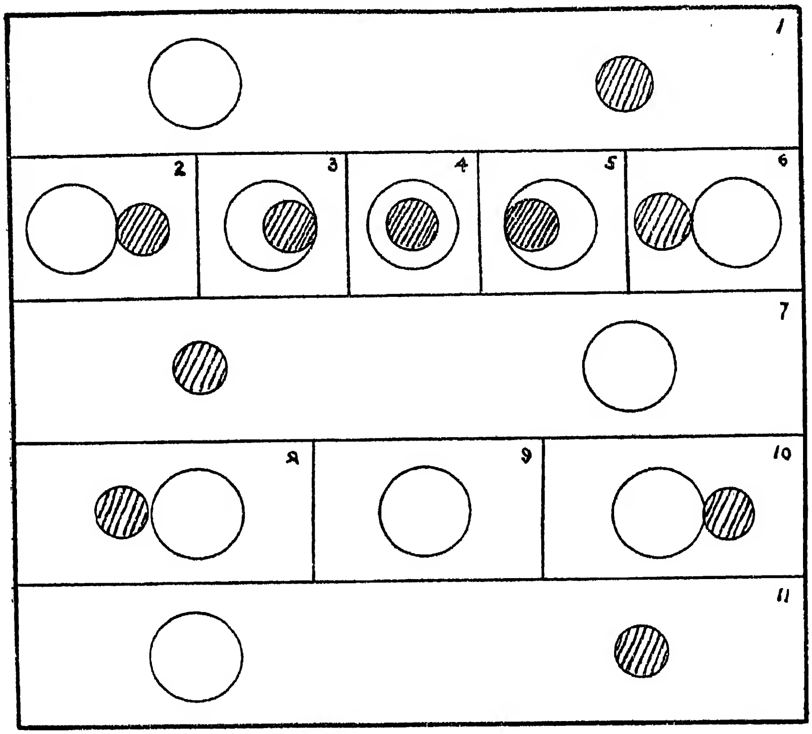


The light curve of Algol is of the form shewn in Figs. 1 and 2. The characteristics are a long period of maximum brightness without variation, followed by a rapid descent to minimum; an equally rapid rise to maximum, followed by a repetition of the long steady period, and then by the same cycle of changes. In other words, we have a considerable time during which the star shines steadily without interference, and then a partial shutting off of the light; this suggests an eclipse and leads us to the idea of a dark body passing in front of a bright one.

If we imagine two bodies revolving round each other, or, more precisely, each revolving round the centre of

gravity of the two, they will occupy successively the positions shewn in Fig. 3; and an observer, situated in the plane

fig. 3

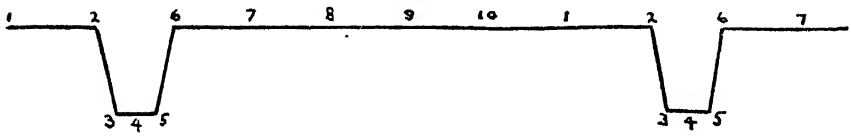


of their orbit, would see, if he were near enough, at stage 1 the dark body D moving towards the bright one B: at 2, the two discs would apparently be in contact, and D would begin to cut off part of B's light: at 3 D is producing the maximum of obscuration, and it continues to do so till 5 is reached, when it begins to pass off again: at 6 D is in apparent contact again and no light is cut off: at 7 D has reached its greatest distance from B and begins to return towards it: at 8 there is again apparent contact, but now D is further away from the observer than B and begins to pass behind it: at 9 D is altogether behind B and cannot be seen at all: at 10 it has emerged again and is seen once more in apparent contact: at 11 it has reached its greatest distance to the right and is in fact at position 1 again.

Now let us translate these appearances into a light-curve.

From 1 to 2 (*vide* Fig. 4) there is no interference and the curve is a straight line. At 2 the shutting off of light begins

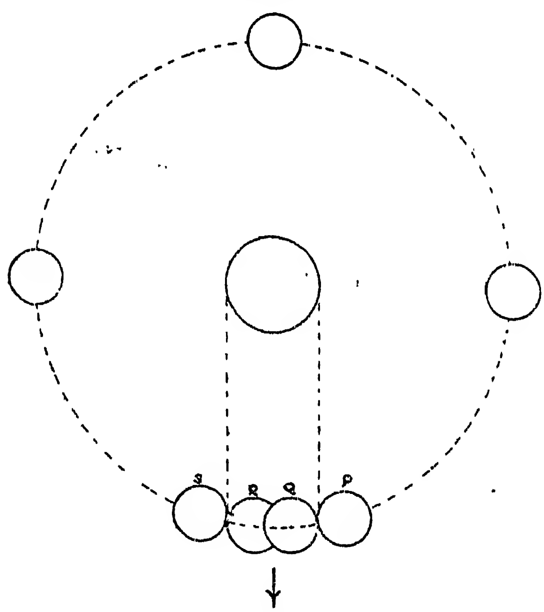
fig. 4



and the curve begins to drop; it continues to do so until first internal contact, stage 3, is reached. From this point to stage 5 the observation is steady and the curve is again straight line. From 5 to 6 the light increases and the curve rises. From 6 through 7, 8, 9, 10, 1 and 2 no change in the light occurs, and the curve is a straight line; and then we arrive at a second eclipse.

In this rough way a curve not very unlike that of Algol has been obtained, but in the Algol curve there is no straight portion at minimum; the curve dips to a certain point and then at once begins to arise again. This part of the curve must therefore be more closely examined.

fig. 5



In Fig. 5 the positions are shewn as seen from a point

above the plane of the orbit, the direction of the observer being shewn by the arrow.

The part of the orbit during which the eclipse is seen is only the small portion between P and S, and only from Q to R is the whole of the dark disc projected on the bright one. The length of the straight piece of the curve at minimum brightness only corresponds to this small portion of the orbit,—roughly, in the above diagram, $\frac{1}{40}$ part of the whole. It is evident, therefore, that in Fig. 4 its length has been much exaggerated. Moreover, in the diagram the dark body has been drawn smaller than the bright one; if it were exactly the same size, then in the diagrams of the stages (Fig. 3), 3, 4 and 5 would coalesce. There would be a diminution of the light down to momentary total extinction, and then the increase would at once begin. I may remark in passing that this consideration brings to light an inconvenience in the use of magnitude-curves instead of true light-curves, to the difference between which I drew attention in the Journal for November. The magnitude-curve of a star which suffers total extinction cannot be drawn, for since the number expressing the magnitude of a totally extinguished star is infinite, we should require an infinite piece of paper to contain the curve. On a true light-curve the point representing total extinction is merely the zero of the adopted scale.

To return to the question of the length of the period of steady minimum, the matter can be approached in another way. We have seen that this length must depend on the relative sizes of the two bodies. The ratio between these can be estimated from the amount of the loss of light that takes place. The magnitude of Algol at maximum is about 2·3 and at minimum about 3·8—a fall of 1½ magnitudes. A fall of 1 magnitude means that the light is divided by 2·516; a fall of 1½ magnitudes means that it is divided by

$$(2{\cdot}516)^{1\frac{1}{2}} = 4 \text{ nearly.}$$

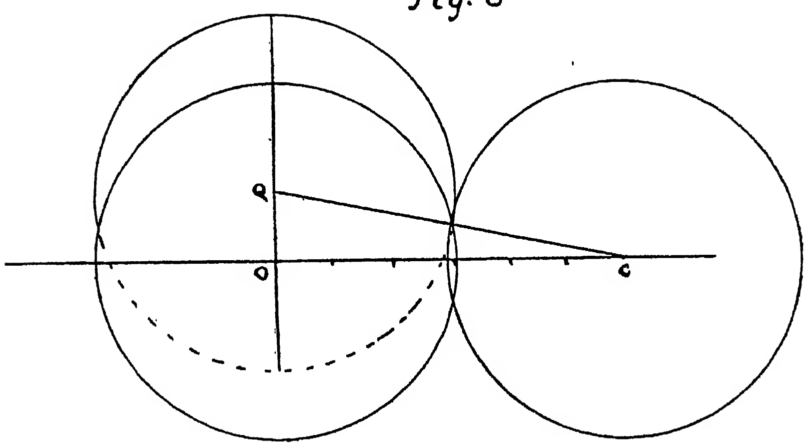
That is to say, at minimum only ¼ of the light is left, or ¾ are cut off. Hence the sizes of the discs are as 4 to 3, the bright one being the larger; that is to say, their diameters are as 2 to 1·7.

Many other considerations, however, would have to be taken into account before any reliance could be placed on these figures. I will only touch on two of these.

In the diagrams, it has been assumed that, as seen from the earth, the dark body passes directly in front of the bright one; but it is by no means certain that this is the case. The plane of the orbit may only pass near the earth, not through it, and thus the dark body would only be partially effective in obscuring the bright one.

We know that the dark body cannot be less than $\frac{3}{4}$ the size of the bright one: let us suppose that they are of equal size and examine what must take place. At the moment of maximum eclipse one-quarter of the bright disc is visible, hence it can be shewn that the centre of the dark disc must at that moment be about four-tenths of the radius below the centre of the bright one.

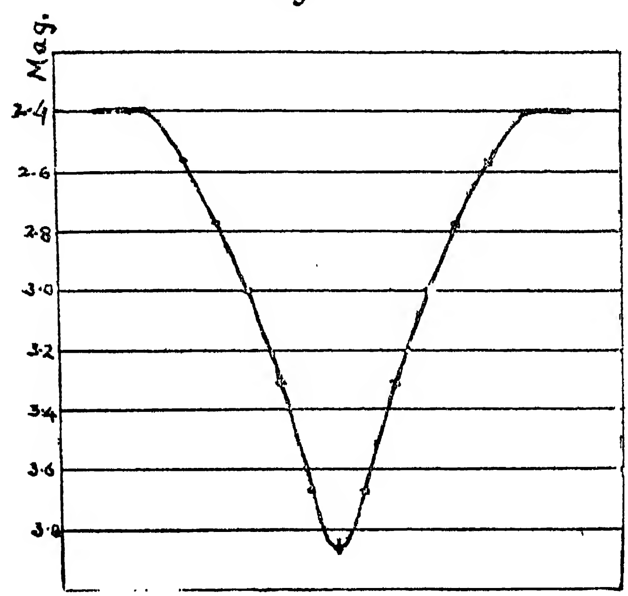
fig. 6



Drawing a horizontal line through the centre of the dark disc (see Fig. 6), and marking the position C of its centre when first contact occurs, all the changes in the light of the star, from the beginning to the middle of the eclipse, occur while the centre of the dark disc moves from C to O. If we divide CO into any number of equal parts and measure, or compute the distances from Q, the centre of the bright disc, to the points of division, we may calculate the amount of the bright disc that is hidden at each successive position of the dark one, and so draw the light-curve of the variation. In order, however, to make a comparison with the curve of Algol obtained by observation, this light-curve must be converted into a magnitude-curve. I have determined the magnitude

of the bright star at 6 points intermediate between C and O, and Fig. 7 shows the resulting curve. It is very similar

fig. 7



to the curve shewn in Fig. 2. It is to be noted that in such a case as I have been supposing there is no steady period at minimum. It would be of great interest to know whether in the Algol curve there is or is not a small period of steadiness at minimum brightness. The curve shewn in Fig. 2 is not derived from a sufficient number of observations to clear up this question, but I have no better one at hand.

There is another point that requires attention. It was supposed that the eclipsing body was dark, but it may be asked whether this is necessarily the case.

Might it not be a body less brilliant than the bright body, but still having some light of its own ?

For instance, if it were the same size as the bright body and totally eclipsed the latter, but itself possessed a brightness equal to $\frac{1}{3}$ of that of bright disc, we should then, when both are fully visible, receive a light of 3 from the one and 1 from the other, or 4 in all ; but when the darker of the two eclipses the other we should receive only the light of the less bright one, or a light of 1, which would agree with the observed change. But in this case, when the darker body is behind the brighter, we should receive only the light from the latter ; that is to say, a light of 3, and there

would be a second less marked minimum half way between each pair of principal minima. But no such secondary minimum has, so far as I am aware, been observed; and we may therefore conclude that the eclipsing body has no light of its own, or at most is very feebly luminous.

The conclusions arrived at from this rough analysis of the light changes of Algol are :—

1. That there are two bodies revolving round each other.
2. That a complete revolution takes place in 2·86 days.
3. That the plane of the orbit passes through, or very near, the earth.
4. That one of the bodies is dark.
5. That the size of the disc of the dark body cannot be less than ⅘ of that of the bright one.

We are not able to say whether the dark body passes directly between us and the bright one, or a little above or below the latter; but if we were able to say whether there is or is not a period of steady minimum, we should be able to answer this question.

The Motions of the Stars.

BY H. G. TOMKINS, F.R.A.S.

The object of this paper is to bring before Members of the Society some of the results of recent investigations of stellar motions with special reference to the theory of Professor Kapteyn regarding the two drifts of stars, and the researches of Mr. Eddington of the Greenwich Observatory. The subject is a very difficult one, and the methods of research are highly technical. Those who wish to study the papers in detail can do so in the monthly notices of the Royal Astronomical Society. In this paper I have set out with a brief history of the idea of stellar motion, and have then indicated from Mr. Eddington's papers the graphical method adopted by him of making the investigation and the main conclusions he has arrived at.

If we watch the heavens from night to night, month to month, and year to year, we notice that the same stars are not always in the same part of the sky above us, and that a star which is to be seen in one direction at one part of the night or year is not in that direction at another. From this we are led to infer that the stars are not immoveable, but have motion. In the early days of astronomy, it was believed that the sun and the stars were fixed in a crystal sphere, which revolved round the earth as its centre. This

notion, of course, presupposed the earth to be at rest, and the sun and stars all to be themselves in motion. It soon came to be recognised, however, that most of this apparent motion would be evident if the earth were in motion and the sun and stars at rest, and Copernicus put forward the correct solution of the problem when he declared the sun, and not the earth, to be the centre of our system, and the earth and planets to be revolving round it. This was at once a recognition of the fact that the motion of the stars might be of two kinds—apparent, due to movement on the part of the earth; and real, due to proper motion of the stars themselves. We are familiar with the former in the rising and setting of the stars, due to the diurnal rotation of the earth, and in the change of the positions of the constellations due to the revolutions of the earth in its orbit during the year. Other less familiar changes are those due to precession and aberration. The effect of the precession of the equinoxes round the ecliptic in its period of 25,868 years is visible in the apparent approach of some stars to the pole and the recess of others. The period is a long one, but the effect is visible after a moderate time.

The present pole star, with which most of us are well enough acquainted, is now about 1° 24′ from the pole. Not so very long ago in point of astronomical time it was about nine times that distance away. At the time of the erection of the Great Pyramid α Dacornis was the pole star, and it is an established fact that the passage way into it was built so that at the bottom this star was visible at its lower culmination.

Aberration, which is due to the time taken by the light of a star to reach the earth, is also another source of apparent motion, and there are others. It is not the purpose of this paper, however, to deal with these apparent motions, and they have only been mentioned in order that they may be excluded from the consideration of the motions of the stars themselves. It is the *real* motions of the stars (as far as we can fathom them) that we are now concerned with. The first astronomer to conceive that beside the apparent motion of the stars, there might be real motion, of the bodies themselves, and to suggest a measurement of it, was Halley of Comet fame in the year 1718. He directed special attention to Arcturus as well as other stars. Perhaps it may now be explained that it is one of the objects of the numerous catalogues of stars which have for so many years been compiled by observatories to try and detect motion of this kind. The place of a star is fixed by its right ascension and declination as it would be seen from the earth's centre,

in arriving at which the effect of sources of *apparent* alteration of place due to the earth, the earth's atmosphere, etc., are taken into account. If, after the lapse of years, the place is again calculated from observation and found to differ from what it was at first, it is evident either that the star has itself moved, or else that it and other stars have moved; or, thirdly, that the whole of one solar system has moved—that is, that the sun with its planets (including the earth) is moving through space. This motion is called proper motion, and it is this which we have now to consider.

In the year 1760 J. Tobias Mayer, from a comparison of his own observations with those made by Römer about 50 years before, found a small number of stars which exhibited differences of position such as have been referred to above. In 1776 Maskelyne and later on others also published lists of the same kind. In 1781 Prevost and in 1783 Herschel took up the subject, and as a result they both concluded that the sun was with its planets in motion in space, and that the whole system was drifting towards the constellation Hercules. This was merely an indication of linear motion. There was no evidence of any orbit in which the sun might itself be revolving in the same way as the earth does round the sun. It is recognized, however, that the motions of heavenly bodies, as far as we can measure them, obey the laws Kepler from which an orbit would be expected. Probably the reason why nothing of the kind has yet been detected is that the distances involved in this tremendous problem are too great, and the periods over which our observations extend are far too short to give any indication of anything beyond linear movement. Future generations—if the records now being compiled live so long—may be able to obtain such evidence: it is doubtful, however, if anything of the kind will be possible for many centuries yet.

Coming to more recent years, Mr. Procter called attention to the subject and pointed out that the fact of the proper motions of stars near one another being nearly the same, supported the assumption that the stars themselves must be in actual motion as distinguished from solar motion. This was another step in advance. Hitherto the motions had been held to indicate the motion of the solar system among the stars; now it was conceived that motion might also exist among the stars themselves—in fact that, instead of being a fixed universe, it might be composed of multitudes of suns or solar systems, including our own, all moving among each other, something perhaps after the idea of the molecules and atoms which we meet with in other sciences.

This was the stage at which the subject stood when Professor Kapteyn and Mr. Eddington began their investigations a few years ago. The idea was that the motions of the stars were at random, and attention was chiefly given to the determination of the movement of our own solar system in space among the stars. Kapteyn's investigations of Bradley's catalogue of proper motions of stars, however, have resulted in the production of evidence to show that the motion of the stars is not at random, and, when all are considered together relative to the sun, he finds evidence of two great streams of stars moving in two fairly well marked directions. I cannot do better than quote a paragraph from Mr. Eddington's first paper on these motions. He says: "Relative to the sun he (Kapteyn) finds two 'favoured' directions of motion instead of one. Kapteyn suggested that there are two systems or 'drifts' of stars; these two drifts are in motion relative to one another. If the whole universe forms one system (or one chaos), we can speak of its motion relative to the sun; but it is more natural, though perhaps misleading, to speak of the sun's motion relative to it. But if there are two systems, we may as well drop the idea of the solar motion altogether, and speak of the motions of the two drifts relative to the sun."

It seems to me that this puts the case very clearly. Kapteyn considers that the stars move in two great streams or drifts, and Eddington has submitted the theory to searching tests.

Briefly, his method has been to assume the motions to be in any direction: then to examine other catalogues than the one selected by Kapteyn, and to see mathematically and graphically whether there is evidence of the two streams.

Now, suppose that on an examination of the catalogue it is found that the number of stars having a proper motion in any number of given directions is the same, and supposing we took a centre and drew radii from it to represent those directions and made the length of those radii equal to the number of stars moving in each direction, we should then have a graphical representation of the whole, and as the numbers of stars were equal in all directions it would be a sphere. Supposing now a small region of the sky is taken, it can be considered as approximately plane, and ignoring the motions in the line of sight, the resulting graph would be a circle.

Next, let us suppose the sky to be divided up into a number of three small regions, each to be investigated separately, we can then in the same way represent the state of affairs

of each by a diagram. Suppose that the number of stars moving in the various directions are not equal, then, if we draw a radius vector in the directions proportional to the number of stars having proper motions in that direction, we shall obtain graphs of shapes other than circles.

Considering the stars to belong to one drift and proceeding in this manner, we obtain figures such as the following for four variations in the number of stars in given directions :—

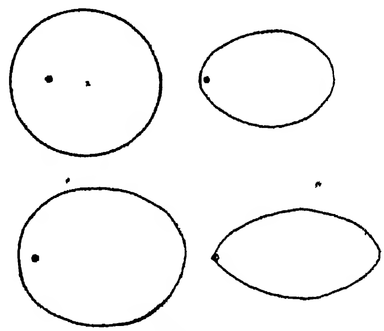


Fig 1

They are of course types of the graphs which might be obtained, and it will be noticed that the maximum is always opposite to the minimum, thus indicating the single drift. On this basis Eddington divides up the portion of the heavens which he has investigated into seven regions, and the resulting graphs obtained are as follows :—

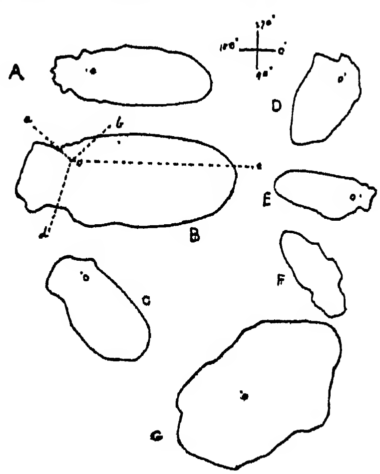


Fig 2

It is quite evident that something is at work in these curves, which makes them differ in a remarkable manner from those in Fig. 1. Taking Mr. Eddington's own explanation of one of them—"Let us consider, for example, the curve and compare it with the theoretical single-drift curves of Fig. 1. Perhaps the most remarkable feature is the extraordinary minimum between *o a* and *o b*. The number of stars having directions of motion within this right angle is found on reference to be only 63 out of 862. But the curve differs completely from the theoretical curves, in that the maximum is not by any means opposite to this, but is along *o c*; in fact there is a sort of secondary minimum along *o d*, where we should have expected the maximum to be."

There is no resemblance whatever between the curve β to those in Fig. 1 based on the single drift, nor has Mr. Eddington been able to bring them into any sort of agreement on that basis. Likewise the other regions also differ largely with the types of the curves of Fig. 1.

Mr. Eddington, therefore, proceeded on the basis of two drifts as suggested by Professor Kapteyn, and as a result obtained the following diagrams, which agree well with those drawn up from the catalogues. He obtains a remarkable

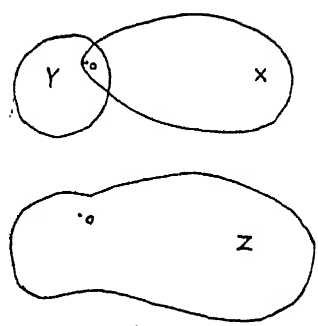


Fig 3

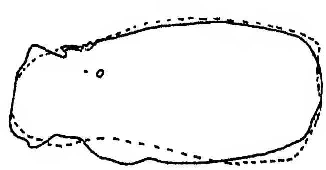


Fig 4

correspondence between the curves of Z in Fig. 3 and β of Fig. 2, which he brings home by direct comparison of the two in Fig. 4.

The curve Z corresponds to a mixture of the stars of two drifts.

Thus far in 1906, therefore, Eddington's researches bear out the theory of Kapteyn. Recently another catalogue has been published by Professor Bose containing 6,188 stars, and Eddington has examined these by the same methods as before. In the meantime research had shown that beside the two main streams there were certain local streams and "moving clusters." The chief of these are the stars of Orion, Ursa Major, Taurus and the Pleiades. Eddington omits these in his recent paper, and for the purpose of the remainder he divides the sky up in 17 regions.

I give below the result he obtains in one of these regions in Fig. 5 A:

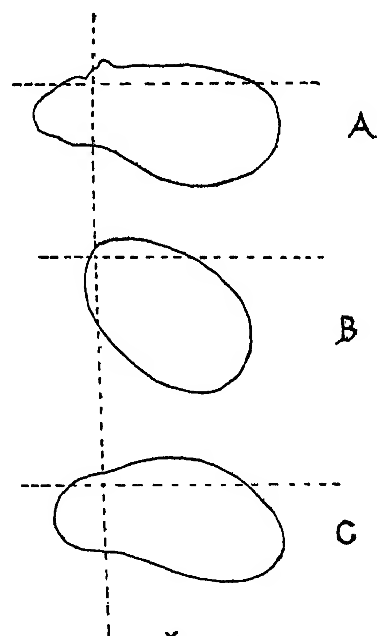


Fig. 5

The nearest approximation he can obtain on the hypothesis of random distribution together with solar motion is β It is obviously unlike. On the two-drift basis, how-

ever, we have C, and it is seen at once that a strong correspondence exists, and so on with the other regions.

Taking now the directions of the first drift shown by the 17 different regions and combining them, it is seen that they all converge towards one apex. Fig. 6 shows this in a remarkable manner.

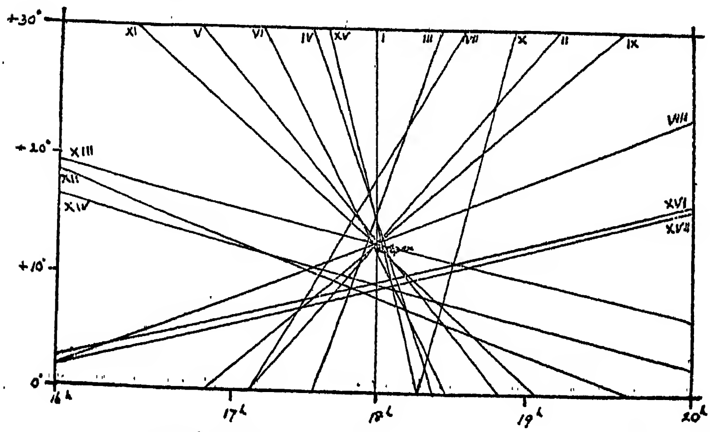


Fig 6. Convergence of the directions of Drift I from the 17 regions.

Similarly with drift II, though in this case the convergence is not so strongly marked. Even so, however, the evidence is as strong as it would be supposing we took a case on the earth and drew great circles from 17 points uniformly distributed over the earth and found that every one of them passed across the Sahara.

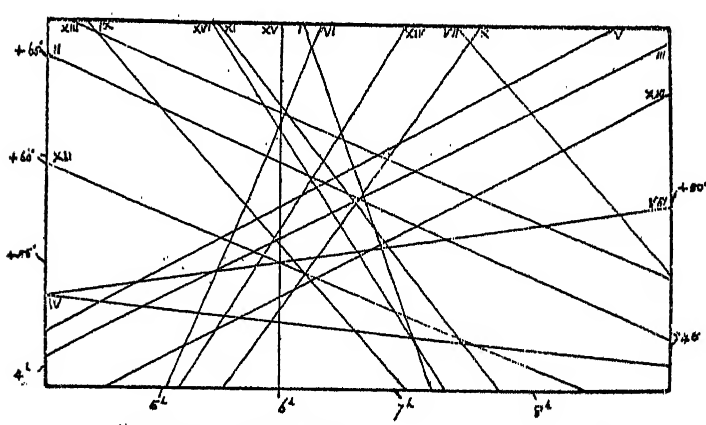


Fig 7 Convergence of the directions of Drift II from the 17 regions.

The positions of the apices thus derived are R.A. 90°.8 Dec.—14°.6 for Drift I and R.A. 287°.8 Dec.—64°.1 for Drift II, which agree closely with similar positions found by Professor Bose from the same catalogue by other methods.

The conclusion we must draw therefore from these remarkable researches is that the visible universe consists of stars composing in the main two great streams, one of which is travelling in the directions just mentioned.

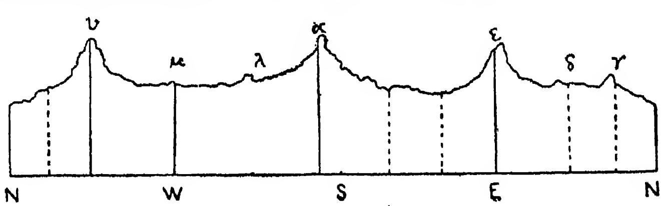
The Crater Clavius as viewed by an Observer on the Moon.

By U. L. Banerjee, M.A.

In my last paper I dealt with the Crater Plato, which is a walled circular plane 60 miles in diameter, with comparatively level interior bed, surrounded on all sides by a mountainous ring varying in height from 3,000 to 3,800 ft. I shall now describe another crater named Clavius, situated between 9° to 21° long. and 55° to 63° lat. It is 142·6 miles in diameter, having an area of 16,000 square miles, surrounded by an elevated mountainous range, the average height of which varies from 9,000 to 13,000 ft. above its plane.

Its western wall rises with a gentle slope from the elevated regions on the west and falls abruptly into a broadly terraced declivity to the interior of the crater, the general elevation there being 12,000 ft. This wall, running northwards, rises abruptly into a lofty peak υ some 17,300 ft. high, situated at the north-western corner of the crater, and then slopes down to an elevation of 9,000 ft. on the north.

Opposite this lofty peak υ and on the east side is another peak ϵ 16,800 ft. high; here the wall again gently slopes down reaching a height of 10,000 to 13,000 ft. throughout the entire south-eastern part, and then terminates into another peak α 16,800 ft. high on the south. Thus the plane is practically surrounded by a chain of mountains, with 3 lofty peaks, the view of which may be graphically represented by spreading out the walls in a straight line thus :—

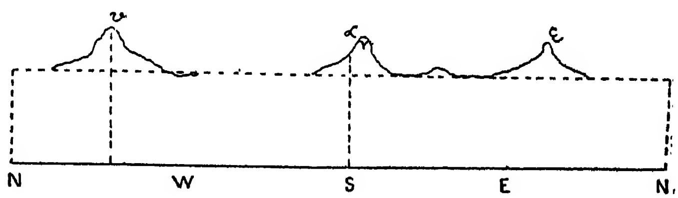


The interior of the crater is not uniformly level throughout, as is generally noticeable in the case of Crater Plato. There are several ring planes, the largest two being on the south-western and north-western corners, about 32 miles in diameter. The walls of the ring plane on the south-western corner are 8,360 ft. high, while those of the other ring plane vary in height from 7,500 ft. to 11,700 ft. Besides these, there are several small ring planes at the centre, the largest and finest of which is 16 miles in diameter, with walls 2,900 ft. above the interior of Clavius, and 9,360 ft. above its own floor. Thus the bed of this ring plane is 6,460 ft. below the plane of Clavius. Another smaller but more regular plane is a little east with walls 6,200 ft. high above its completely level interior.

The beds of the largest ring planes at south-western and north-western corners are not perfectly level ; there are a number of long ridges and some mountains as well as some small craters. Short mountain arms extend on to the interior of Clavius, one of which contains a row of crater pits

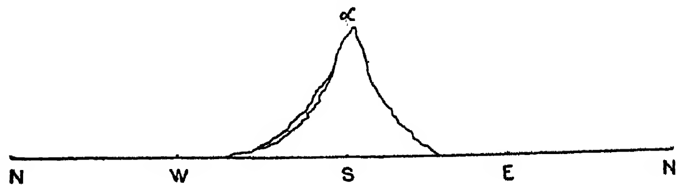
Now let us consider the views which an observer will get of the surrounding mountains and peaks by standing at different positions in the crater.

(1) If he stands at the centre, all the walls would be about 71·3 miles distant from him. Applying the formula $h = 2{\cdot}44\, d^2$, (when h = height of the walls in feet invisible to him, d = distance of the walls from him in miles) we find that 12,400 ft. of the walls from the base will be invisible to him. The entire chain of the mountain walls will therefore practically disappear from his sight, and he will see only 4,000 to 5,000 ft. of the three peaks α, υ and ε, and about 600 ft. of the wall on the south-eastern border.

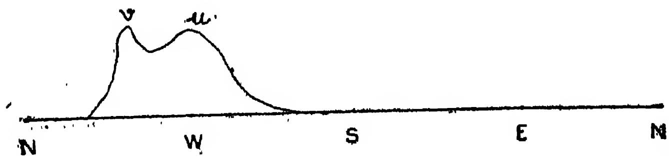


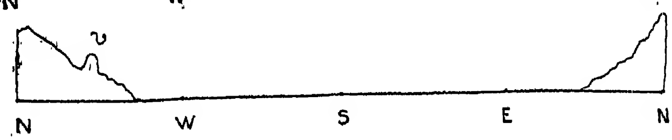
(2) If he moves to southern end, the peak α and the mountains on both sides of it will appear to him, while the peaks υ and ε will be about 123 miles distant from him and disappear altogether from his view.

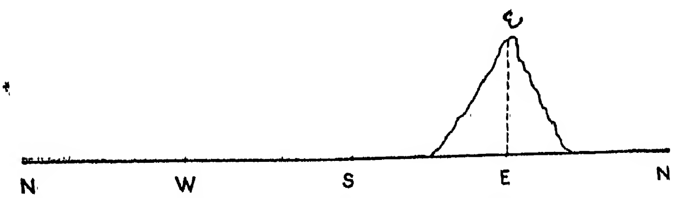
The mountain ring will appear to him as shown below :—



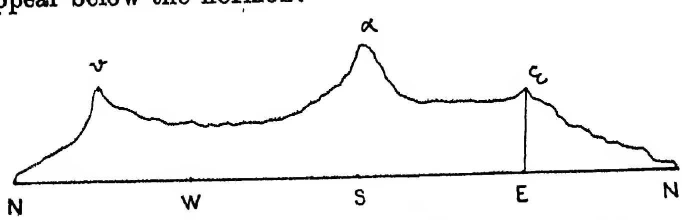
If he now moves to the west, north and east walls the views of the mountains will successively be as represented below :—







If he can once reach one of the peaks, say α, and stand on the top of it, he will see the entire mountain chains on all sides, the peaks υ and ε will appear much lower and lower, and the mountains on the north just opposite him will disappear below the horizon.



An interesting view will be obtained if he may get over the walls of one of the largest craters, say one on the south-western corner. Its diameter being 32 miles, only 625 ft. of the base of the mountain will disappear from his view, and he will see a ring of mountains all round 8,735 ft. high.

If he stands at the top of the mountain chain, he will have full view of the wall near him, and only half of the walls on the opposite. The whole mountain chain will appear as shown below :—

As the observer standing on the summit of the peak α will have a full view of the tops of the mountain chain all round, he will see a magnificent appearance of the peaks and the bed of the plane below during the lunation period. With the rise of the sun on the west, the few peaks on the western wall catch the light first, and soon after the entire wall on that side gets illuminated. Gradually the tops of the mountains surrounding the ring planes in the interior come out from the shadow of the night, while the dark mass of shadow still envelopes the floor of Clavius. A little while after light points appear on eastern walls rapidly widening into an illuminated mountain chain all round. By the time the tops of the mountains get distinct, five streaks of light begin to run across the dark mass of shadow on the bed of the crater, breaking through the mountain passes on the west wall. Gradually these streaks widen near the centre, and rapidly illuminate the interior. The ground at the foot of the western wall and the ground beyond the eastern wall still remain in the shadow of the mountains, while the ring planes in the middle have their floors still totally immersed in darkness. As the sun rises higher and higher, the shadows of the mountains get shorter and shorter, and darkened interiors of ring planes get illuminated. At mid-hour the whole surface becomes fully illuminated, and the whole crater becomes a mass of light.

Meteors.

By THE DIRECTOR OF THE SECTION.

In February there are five meteoric showers ; the first is from 5th to 10th, the second and third on the 15th, and the fourth and fifth on the 20th. They are not very important, but as the first deserves more attention than the others, a brief description of it is now given. The meteors of this shower are slow and bright, and the radiant point is situated in the constellation Auriga. Most persons, I suppose, know the constellation Orion. At about 9 p.m. it can now be seen very high up in the sky. The line joining the three

stars which form Orion's belt (*i.e.*) δ, ϵ and ζ Orionis points to Aldebaran, the first star in the constellation Taurus, and on the north and a little towards east of it will be found Capella (*i.e.*) α Aurigæ. It is of distinctly yellowing color and its magnitude is 2. The R. A. and Dec. are 5 hrs. 10 mts. and 45° 55′ N. On the 5th February next it will cross our meridian at 9 hrs. 4 mts. p.m. and will be 23°22′ north of our zenith. Towards east will be found the second star in the constellation, namely β Aurigæ, a star of 2nd magnitude; and south of it is θ Aurigæ. On the west are the three stars ϵ, δ and i Aurigæ. Of these ϵ Aurigæ is a variable star, the magnitude varies from 3 to 4·5; the magnitudes of the other two stars are about 3. The R. A. and the Dec. of the radiant point of the shower are 5 hrs. and 41° N. They are almost exactly the same as those of the star η Aurigæ, whose magnitude is 3·2. On the 5th February the radiant point will cross our meridian ten minutes before Capella, and at that time it will be 18° 34′ north of our zenith.

The last Boötid shower of 2nd and 3rd January, it appears, was very poor. On the morning of the 3rd January I watched from 3 hrs. 16 mts. a.m. to 3 hrs. 56 mts. a.m. standard time, and observed only one meteor. The following is its description :—

Duration.—$\frac{3}{4}$ of a second.

Magnitude.—3.

Direction.—Its direction is represented by the straight line drawn a little north of δ and ϵ Ursæ Majoris and parallel to the straight line joining those two stars.

Color.—It appeared to be white.

Note on a Large Meteorite.

BY H. H. THE MAHARAJ RANA BAHADUR OF JALAWAR.

A very luminous meteor was visible here at about 3-55 p.m. on Sunday, the 22nd January 1911. The meteor shot across the northern sky from west to east. It was as bright as a rocket and as big as a cannon ball. The forepart was radiant blue, the middle white, and the back purple. It burst into two on the eastern horizon and gradually got out of sight. A loud and prolonged report like that of thunder followed. It took about five minutes to reach us, and hence the surmise that the meteor burst at a point 60 to 65 miles away from here. The long milky trail left by the meteor rapidly vanished, the sun shining in full glare at the time.

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the Month of March 1911.

Sidereal time at 8 p.m.

	H.	M.	S.
March 1st	6	33	6
,, *8th*	7	0	42
,, *15th*	7	28	18
,, *22nd*	7	55	54
,, *29th*	8	23	30

From this table the constellations visible during the evenings of March can be ascertained by a reference to their position as given in a Star Chart.

Phases of the Moon.

		H.	M.
March 8th	First Quarter .	4	32 a.m.
,, *15th*	Full Moon . .	5	29 a.m.
,, *23rd*	Last Quarter .	5	56 a.m.
,, *30th*	New Moon . .	6	8 p.m.

Meteors.

Date.	Radiant R. A.	Radiant Dec.	Character.
March 1-4 . . .	166°	+ 4	Slow : bright.
14th . . .	250	+54	Swift.
18th . . .	316	+76	Slow : bright.
24th . . .	161	+58	Swift.
27th . . .	229	+32	Swift : small.
March-May . . .	263	+62	Rather swift.

The showers in the month of March are not likely to be very brilliant.

Planets.

Venus—Is an evening star. It sets 1 hr. 52 mts. after sunset.

Saturn—The position of the planet on 15th March at 8 p.m. will be R. A. 2 hrs. 10 mts. 20 secs. Dec. 10° 47′ 9″ N. Time of its setting 8 hrs. 39 mts. p.m.

Mars.—The position of the planet on 15th March at 8 p.m. will be R. A. 20 hrs. 14 mts. 31 secs. Dec. 20° 49′ 17″ S. Time of its rising will be 2 hrs. 56 mts. a.m. on 16th March.

Jupiter.—The position of the planet on 15th March at 8 p.m. will be R. A. 14 hrs. 48 mts. 44 secs. Dec. 14° 50′ 22″ S. The time of its rising will be 9 h. 19 m. p.m.

The New Star.—The position of this body is R. A. 22 hrs. 32 mts. 10 secs. and Dec. +52° 15′ 56″. Its magnitude in January was 7·5, but it has faded rapidly.

Extracts from Publications.

The attention of Astronomers is being directed to a new star which has suddenly blazed forth in the Milky Way in the constellation Lacerta. It was first noticed by Mr. T. E. Espin of Towlaw, Durham. Immediate steps were taken at the Royal Observatory, Greenwich, to keep the new star under vigilant observation. The Astronomer Royal, Mr. F. W. Dyson, assisted by Messrs. Meloth and Stevens, succeeded in photographing it on Friday night. It is situated in 22 h. 32 m. 10 s. Right Ascension, and 52° 15′ 26″ declination (north). Its present magnitude is estimated at 7·5; it is close to the 8·8 magnitude star A. G. C. 7,788. The Milky Way often affords examples of these new stars; it is generally supposed that one of the faint stars of this vast constellation passes in its orbit through different nebulosities, and shows by its violent superficial activity that resistance has been offered to its progress through space. The spectra of these temporary stars offer a close resemblance to that of the solar chromosphere, the incandescent gaseous layer which envelops the sun; hence it may be reasonably inferred that the conflagration is not caused by the collision of two huge bodies, but in the manner previously stated. These temporary stars are vastly, remote, for none have shown a perceptible parallax, nor do they appear to have proper motion; they materialise suddenly, and gradually sink into their former obscurity.

Sir Robert Ball telegraphed to the *Times* from Cambridge Observatory on Monday night: "Mr. Espin's new star in Lacerta was observed here by Mr. Hinks last night. The star was easily identified by its redness. The spectrum shows four conspicuous bright lines in red, yellow, blue-green, and blue. The red hydrogen line was the most intense. The star was observed again this evening at seven o'clock. It has lost nearly half its magnitude. The

brightness of the spectrum was very similar to that of last night, the red hydrogen line being still the most conspicuous."

[*English Mechanic.*

The Astronomical prizes of the Paris Academy have been awarded as follows :—The Lalande to Drs. Cowell and Crommelin for their researches and investigations on Halley's Comet ; and the Valz to M. Stephane Javelle for his researches on Comets and Nebulæ. The Taussen Medal goes to Professor W. W. Campbell for his spectroscopic discoveries and investigations.

[*English Mechanic.*

In the *Bulletin Astronomique* Dr. P. Stwohant suggests that the sun is probably a unit in a stream of stars moving through space in the same direction with a common velocity. As a primary index, he takes those stars of which the movements, relative to the sun, are small, and then reduces their movements to a common plane. The result, remarks *Nature*, is certainly striking, for Dr. Stwohant shows that the seven stars α Cassiopeiæ, β Persei, α Persei, α Scorpionis, γ Cygni, ϵ Pigasi, and α Pegasi are all travelling towards a polar area of only 14° radius, with velocities ranging between 11 and 22 kilometres ; towards the centre of this area the sun is moving at a rate of 19·4 kilometres. The probability that of the 105 stars brighter than magnitude 2·5 seven should accidentally show this common motion is very small ; but it must be borne in mind that the data on which the result is based are, especially in the case of parallax, open to corrections. Dr. Stwohant suggests that, with the accumulation of further more trustworthy data, other stars may be found to belong to the same stream, and he cites γ Pigasi, γ Persei, ζ Geminorum, α Hydræ, ϵ Leonis, η Leonis, Ψ Ursæ Majoris, η Virginis, γ Aquilæ, α Pavonis, and η Pegasi as stars having small proper motions, and of which the radial velocities relative to the sun are also small.

[*English Mechanic.*

I believe that the exposure given with the 60-inch reflector to photograph stars of magnitude 21 was 240 minutes, so that, adopting the formula exposure × brightness is constant, and the ordinary law of visual magnitudes, it follows that with 40 minutes' exposure, stars of magnitude 19 would be shown. It generally takes an hour to photograph the faint satellites of Jupiter, which are considered to be about magnitude 17, with the 30 inch reflector, though they have been got with less. As I have said, 40 minutes' exposure

with the 13 inch refractor shows magnitude 14·5; so here may be some data for a law.

[*Mr. Hollis in the English Mechanic.*

It is not possible to set an equatorially mounted telescope exactly on the Pole, unless the Polar axis is perfectly adjusted to point to the Pole, and the instrument is perfect as to its axis, that is to say, the declination axis must be exactly at right angles to the Polar axis, and the line of collimation of the telescope exactly at right angles to the declination axis. Of course, it is possible to conceive the Polar axis not pointing to the Pole, and that there is some particular maladjustment otherwise which would allow the telescope to be set exactly on the Pole; but, speaking generally, it requires perfect adjustments, and this is a little difficult to realise. I remember Sir Robert Ball saying not long ago at the Royal Astronomical Society that it is generally known among surveyors that (miracles apart) it is impossible to set the telescope of an altazimuth on the zenith, and Sir Robert went on, in his usual humorous way, to explain how this was somehow connected with the mathematical conception of circular points at infinity. But passing over this theoretical point, we come back to the practical fact that it is generally impossible to set the Polar axis exactly on the celestial Pole, and if it is not set exactly on the Pole, it is impossible to get perfect images on a photographic plate. The stars will leave trails whose length is proportional to the angular error of adjustment of the Polar axis and to the length of time of exposure. In fact, at Greenwich, and no doubt at other places, this principle is used to adjust the photographic equatorials. A plate is put in the telescope, the clock drives it for an hour, and exposure is made at the beginning and end of that time. If there are two images of each star, the distance between them (which is the same, and in the same direction, for every star) is a measure of the error of adjustment, and an indication of its direction.

[*Mr. Hollis in the English Mechanic.*

Many readers doubtless are acquainted with Mr. John Evershed, who was an amateur solar spectroscopist, but joined Dr. Michie-Smith a few year ago as his chief assistant at the Government Observatory at Kodai Kanal, India. Dr. Michie-Smith is now retiring, and Mr. Evershed is to be Director. The new Chief Assistant will be Mr. Royd, from the Victoria University, Manchester. Another recent appointment is that of Mr. Chapman, also a graduate of Manchester and of Cambridge, to be one of the Chief Assistants at Greenwich.

[*Mr. Hollis in the English Mechanic.*

The Astronomer Royal in the *Times* of January 14, says: "I have received from Professor Pickering the following communication dated December 31, with reference to the new star discovered by Mr. Espin.—'This object, which will be designated as Nova Lacertæ, was observed last night visually and photographically at Harvard College Observatory. The collection of photographs shows that it was invisible November 19, 1910, but appeared on November 23 and December 7. It was then equal in brightness to ρ Lacertæ, photographic magnitude 5·00. Its photographic magnitude last night was about 7·0. It does not appear on several early photographs, the first taken on December 1, 1887, showing very faint stars. Photographs of the spectrum by Mr. E. S. King showed eleven bright lines. From photometric measures by Professor Windell the Nova appears to be 1·50 magnitudes brighter than + 51° 3420 magnitude 8·7. Observations by Mr. Campbell with Angelander's method make the photometric magnitude of the Nova 7·1. It is visible with an opera glass.' It is interesting to note that the new star remained undiscovered from November 23 to December 30."

[*English Mechanic.*

Mr. Lynn writes on the subject of the Total Solar Eclipse of April 1911:—

"The date of the eclipse in question will be the 28th of April, and the phenomenon will not be visible in any part of Europe, Asia, or Africa. The central line will pass from the south-east coast of Australia in a north-eastern direction over the Pacific Ocean, nearly (but not quite) reaching Central America. A partial eclipse will be seen in Tasmania and New Zealand in the early morning, and in the south-eastern parts of the United States and in Cuba and its neighbourhood in the late evening.

But the totality will cross land only over some of the small islands in the Central Pacific Ocean, and it is to one of these that I wish to draw attention. Its duration will be longest on what is called Christmas Island, where it will amount to nearly five minutes. The Island derives its name from the fact that it was discovered by Captain Cook in his last voyage (which ended so disastrously) on the 24th December 1777. He celebrated Christmas day there, and remained off the Island (when some of his people had unpleasant experiences in a fog) until the end of the year. Cook himself, however, called it Turtle Island from the abundance of turtle found there. It is about 60 miles in circuit, with a very large lagoon, and has a good anchorage

on the western side. For many years it was much resorted to, especially by Americans, for guano.

Cook observed on the Island the eclipse of the sun on the 29th December 1777, which was total further to the south. The latitude of Christmas Island is about 2° north; its longitude about 157° west. Cook calls it 203° east, reckoning all round easterly."

[*Journal of the British Astronomical Association.*

Comet Notes.—Halley's Comet has been reobserved at Yerkes, Helwan, Nice, and Algiers. The magnitude is about 14. The connection of Elull's ephemeris was + 13*s.*,—0·′5 on November 11, + 9*s.*—0·′3 on December 7. As the Comet is approaching the earth till February 9, observations may be expected for two or three months more.

[*The Observatory.*

Photographic Magnitudes.—There is now being developed in more than one quarter schemes for determining photographic magnitudes. Professor E. C. Pickering has set down steps of a scheme in various publications of the Harvard Observatory, one being 'Circular 160,' dated 1910, August 1, from which most of the following notes are extracted.

A "photographic magnitude" is a number which will indicate the effect of a star's light on a photographic plate, just as a photometric magnitude represents its effect on the eye.

Photographic and photometric magnitudes are not the same, but they have some relation.

It is found that, within limits of observation, the colour of all stars whose spectrum is of the same class is the same. The photographic magnitude depends on star-colour, and constants may be found for each class of spectrum to reduce the photometric to photographic magnitudes, as follows :—

B.	A.	F.	G.	K.	M.
—0·31	0·00	+0·32	+0·71	+1·17	+1·68

That is, if the photometric magnitude of a star whose spectrum is of class B, be 5, its photographic magnitude is 5·00—0·31 = 4·69. Explanation of the zero under heading A will be found in the next paragraph.

The scale of photographic magnitudes has to fulfil certain conditions. First, if the intervals are equal, or in arithmetical progression, the intensities of the corresponding lights should be in geometrical progression. Secondly,

the ratio of the geometrical progression should be 2·512, whose logarithm is 0·400, as in the case of photometric magnitudes. Thirdly, having such a scale, it is necessary to adopt a zero, and this is chosen by Professor Pickering so that the photometric and photographic magnitudes of stars whose spectrum is of the first type, or of class A, should be the same. It is found that, if the photographic magnitude (M) be computed from the measured diameter (d) by the formula M =C—N Vd, first proposed, we believe, by Sir William Christie (Mon. Not. Vol. lii), the first two of the above conditions are satisfied, the constants of the formula, C and N, being determined for individual plates by help of the known photographic magnitudes of stars on them.

Professor Pickering is selecting, or has selected, certain stars as standard, and is assigning a photographic magnitude to these. It will be possible to compare all other stars with these through the measures of their photographic images, and so find the photographic magnitude of any star, though the process may be laborious until the system has been much developed. On the other hand, if the differences given in the earlier part of this note are well founded, it may be possible to determine a star's photographic magnitude by finding to which spectrum class it belongs, and applying the appropriate difference to its photometric magnitudes.

There is another method of determining the magnitudes in a more absolute way by directing a certain proportion of a star's light, so that the image of a tenth magnitude star (say) on a plate is accompanied by an apparent image of a fifteenth magnitude star, and comparison of the large and small images of different stars on the same plate will give means of forming a scale, further details of which plan may be found in 'Harvard Annuals," Volume 26.

The above are some of the points in a large and difficult problem.

[*The Observatory.*

The Markings of Mars.—It seems fair to the observers at Flagstaff to give as much prominence as possible to a letter in "Nature" of November 10 last, by Mr. James Worthington of High Wycombe. Mr. Worthington has just returned to this country after a series of visits to the observatories of America. He observed Mars at the Lowell Observatory from 1909 September 27 to October 25 with the 24-inch refractor stopped down generally to 18-inches. At first the seeing was bad, and he saw practically nothing, but as his eye got accustomed to the work, and the seeing

improved, canals gradually became visible, until, on a night of peculiar clearness, October 25, he saw Mars with canals and oases so distinctly and steadily without intermission for an hour and a half that no doubt was left in his mind as to the reality of the features shown in Professor Lowell's drawings. He writes : "Nothing that I had hitherto seen had prepared me for the astonishing steadiness and fineness of the details visible on this superb night"; and later on "As to the deductions which Professor Lowell has drawn from his observations, I have nothing to say except that the startlingly artificial and geometrical appearance of the canals did force itself upon me."

[*The Observatory*.

Notices of the Society.

The Common Seal.

The illustration which accompanies this number of the JOURNAL is a representation of the Common Seal of the Society which, through the kind offices of Lt.-Col. Lenox Conyngham, R.E., F.R.A.S., has been designed for the Society by Mr. F. C. Scallan; the print is taken directly from the engraving.

The Seal has been approved by the Council and was accepted by the members at the last meeting. It now only remains therefore to complete Bye-law No. 57, which will be done this month.

It may be mentioned that the Seal was selected from several designs, one of which came from the pen of Mrs. Colquhoun, a member of the Society, and the acknowledgments of the Council are due to all those who have assisted them in the matter.

Election of Members.

The attention of members is invited to Bye-law No. 14 regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherjee.

The Library.

A subscription list for the furnishing of a Library has been opened, and a good many members in Calcutta have

put their names on it. The Library will be available to members both in and out of Calcutta, and members who have not already done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

Mr. A. Lawrie having been obliged to resign the Librarianship owing to his transfer to Burma, the Council have, under Bye-law No. 4, appointed Mr. Ashutosh Mitra to be Librarian in his place.

Subscriptions.

Some of the subscriptions are still due for the current session from members. Those who have not yet done so are requested to remit the amounts to the Treasurer.

The Treasurer will also be glad to receive those donations promised for the Library and quarters which have not already been paid, as the Council wish to take full advantage of the promised assistance as soon as possible during the present session.

Classes for Beginners.

The Council have arranged to hold a series of four classes for beginners in Calcutta, to enable those who wish to learn the rudiments of the science and how to use their star charts to do so. Mr. B. M. Rakshit, late of the Alipore Observatory, has kindly consented to hold the classes, and the names of those who wish to take advantage of the classes should be sent to him at 77-3, Musjid Barry Street, Calcutta, or to the Secretary, Mr. P. N. Mukherjee, without delay to enable a commencement to be made on an early date.

Lunar Section.

The Revd. J. Mitchell having resigned the directorship of the Lunar Section owing to his furlough to Europe, the section has been taken over by Mr. H. G. Tomkins, Barrackpore.

Meetings.

A special General Meeting will be held on Tuesday, the 28th February 1911, in the Imperial Secretariat Buildings, at a quarter to 5 p.m., for the purpose of passing Bye-laws, for the regulation of the Library, and for the amendment of Bye-laws Nos. 4 and 57.

It will be immediately followed by the usual ordinary meeting of the Society.

The ordinary meetings of the Society will be held on the following dates :—

1911.

February 28th.	May 30th.
March 28th.	June 27th.
April 25th.	

The meetings will commence at 5 p.m. and, until further notice, will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

(2) *Secretary (Scientific)* . W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.

(3) Do. *(Business)* . P. N. MUKHERJI, M.A., F.S.S. Imperial Secretariat Buildings, Calcutta.

(4) *Treasurer* . . . U. L. BANERJEE, Office of the Acct. General, Koila Ghat Street, Calcutta.

(5) *Librarian* . . . ASHUTOSH MITTRA, M.A. 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.

(6) *Editor* . . . J. J. MEIKLE, 8, Hastings Street, Calcutta.

(7) *Directors* :—

General Section . . DR. E. P. HARRISON, Presidency College, Calcutta.

Lunar Section . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

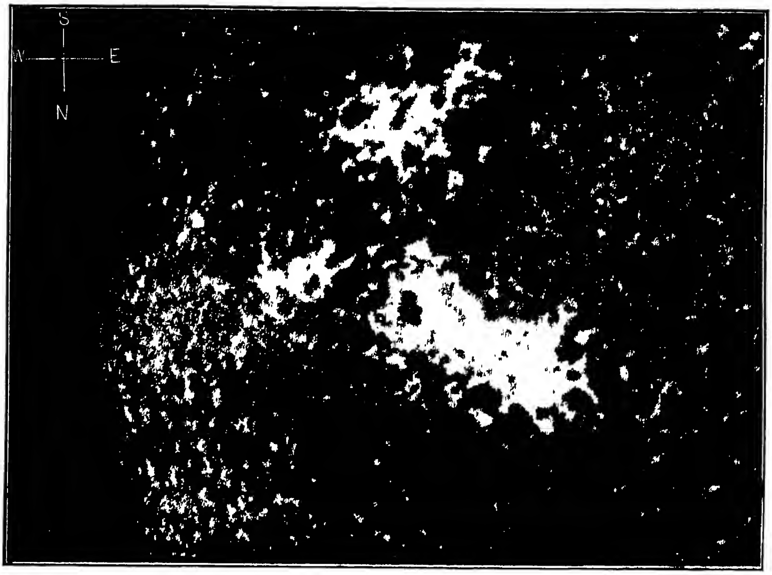
Meteor Section . . B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.

Variable Star Section . LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., United Service Club, Calcutta.

Photography . . R. J. WATSON, 37, Park Road, Barrackpore.

Instruments . . . S. WOODHOUSE, 1, Little Russell Street, Calcutta.

SUN SPOTS TAKEN AT KODAI KANAL OBSERVATORY IN THE 'K' LIGHT WITH THE SPECTROHELIOGRAPH.



1. Two large spots with their trains of Flocculi approaching the west limb of the Sun. Taken 12th September 1908.

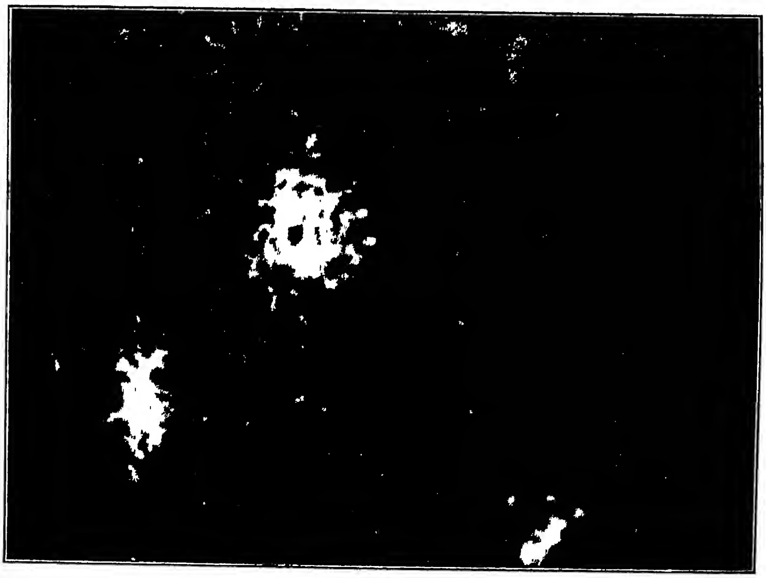


Photo.-Engraved & printed at the offices of the Survey of India, Calcutta, 1911.

2. Spot of September 1909, taken the day before the great magnetic storm with which it was associated.

The Journal

of the

Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [NO. 5.

Report of Meeting of the Society held on Tuesday, the 28th February 1911.

H. G. TOMKINS, F.R.A.S., *President*, in the Chair.
P. N. MUKHERJI, M.A., F.S.S., *Secretary*.

The Ordinary Monthly Meeting of the Astronomical Society of India was held in the Imperial Secretariat Buildings (ground floor) on Tuesday, the 28th February 1911, at 5 p.m.

The meeting was opened by the President, who called on Mr. P. N. Mukherji, Secretary to the Society, to read the Minutes of the previous Meeting, which were duly confirmed. The following donations were announced and a vote of thanks accorded to the donors :—

Library.	Rs.	A.	P.
P. N. MUKHERJI, ESQ., M.A., F.S.S.	20	0	0
R. W. GILLAN, ESQ., B.A., LL.B., I.C.S.	32	0	0
THE HON'BLE MR. J. S. MESTON, C.S.I., I.C.S.,	20	0	0
J. C. MITTRA, ESQ., M.A., B.L.	20	0	0
S. C. MITTRA, ESQ., M.A., B.L.	5	0	0
J. C. DUTT, ESQ., M.A., B.L.	10	0	0
JATINDRA NATH BASU, ESQ., M.A., B.L.	10	0	0
W. J. BRYNING, ESQ.	5	0	0
E. P. HARRISON, ESQ., Ph. D.	15	0	0
D. N. MULLICK, ESQ., M.A., F.R.S.E.	10	0	0
C. W. PEAKE, ESQ., M.A. (OXON)	25	0	0
SURANATH MAITRA, ESQ.	1	0	0
C. N. RAMASWAMI, ESQ., M.A.	2	0	0
T. C. RAY, ESQ., B.A.	2	0	0
H. M. COOK, ESQ.	15	0	0

	Rs.	A.	P.
Mrs. M. Percy Brown .	5	0	0
R. H. Dracott Lacey, Esq. .	5	0	0
Rai Mati Lal Ganguli Bahadur .	5	0	0
F. Allan Lawrie, Esq. .	5	0	0
H. B. Holmes, Esq. .	25	0	0
J. H. Manning Fox, Esq. .	10	0	0

Quarters.

J. C. Dutt, Esq., M.A., B.L. .	10	0	0
E. P. Harrison, Esq., Ph. D. .	15	0	0
D. N. Mullick, Esq., M.A., F.R.S.E. .	10	0	0
E. W. Peake, Esq., M.A. (Oxon) .	15	0	0
H. M. Cook, Esq. .	15	0	0
Rai Matilal Ganguli Bahadur .	5	0	0
H. B. Holmes, Esq. .	25	0	0

Donation of Books, &c.

R. T. Watson, Esq. .	Klein's Star Atlas.
C. N. Ramaswami, Esq., M.A.	Comets and Meteors, by Sir R. Ball.
W. E. Buchanan, Esq. .	Working plans of a Speculum Grinding Machine.
W. J. Simmons, Esq. .	Two Planispheres.
Prof. Emmanuelli .	Paper on the Total Solar Eclipse of April 1911.
Prof. Lowell .	Four slides of Mars, Jupiter and Saturn.

The election of the following members by the Council was confirmed :—

The Hon'ble Mr. Bhupendra Nath Basu, M.A., B.L.
Pulin Behary Das, Esq., M.A.
A. C. Jore, Esq.
Col. F. Hawkins, I.A.
Rai Sahib Gopal Chandra Chattopadhaya, B.A., C.E.
Jogesh Chandra Ray, Esq., M.A.
Dr. Zia Uddin Ahmed, M.A., D.Sc., Ph.D., F.R.A.S.

The President next announced that the Society had received letters from the Royal Astronomical Society and the British Astronomical Association, and that both these two Societies had put the Astronomical Society of India on their list of exchanges. The thanks of the Astronomical Society of India was unanimously accorded to these Societies. The President also announced that he had a letter from Professor Lowell, of the Flag Staff Observatory, congratulating the Society on their start in India and wishing it every success. Professor Lowell stated in his letter that he was

sending out some lantern slides of Mars, Jupiter and Saturn to the Society, which he hoped would prove of interest. A vote of thanks was accorded to Professor Lowell. The President also announced that Mr. Evershed, now Director of the Kodai Kanal Observatory, had kindly consented to forward the contents of such Kiel cablegrams as might be of interest to the Society, if the Society were willing to pay for the Indian telegram. It was explained that Kiel was the central bureau, to which most of the Astronomers in the world communicated their discoveries, and that these were then communicated to all important observatories. One such observatory was Kodai Kanal, and it was a matter of much congratulation that Mr. Evershed had so kindly agreed to forward on the news to the Society. The result would be that important discoveries and items of astronomical interest would appear on the notice board of the Society very shortly after the event, and also find a place in the next JOURNAL.

A hearty vote of thanks was accorded to Mr. Evershed. The President next remarked that owing to the growth of the Society, and consequent increase of its work, it had been found necessary to appoint a paid man to look after it, and Mr. Ramaswami had been duly appointed on a salary of Rs. 25 per month. This was confirmed. He also remarked that 20 or 30 members had joined the classes held by Mr. Rakshit, the first of which classes was to be held on Friday, the 3rd instant, at 5 p.m. Members wishing to join these classes were requested to communicate with the Secretary.

The first paper of the evening from Mr. Buchanan of Simla, on the grinding of a 16″ reflector, was then read by the President, while Mr. Saroda Charan Mittra took the Chair.

Mr. N. Dhar.—With the permission of the President, I should like to remark that I see that in this case the thickness of the glass was only 2½″. This in my experience is rather thin, and I think I am right in saying the accepted thickness is usually one-sixth of the diameter of the mirror. Of course the difference is not very great, but with so large a disc I should have thought the full thickness necessary. I have usually found that a thin mirror is troublesome under the very fine method of testing which has to be adopted.

Another point is the grinding tool. I notice it was made of zinc. I have generally used two discs of glass—one for the mirror and the other for the tool. When these are ground together, the upper one—the mirror—becomes concave and the other convex. I find this satisfactory and

easier. Another point is the carborundum. I have never used carborundum and very rarely emery. I generally make use of sand.

The President.—Do you use sand for your fine grinding ?

Mr. Dhar.—Yes. I am quite able to read print through a sand-ground glass.

The President.—I presume you wash your sand in the same way as the emery ?

Mr. Dhar.—Yes, and to prevent sticking I keep it from getting too dry.

The President.—As regards the diameter of the mirror, Professor Richie makes it $\frac{1}{6}$th or $\frac{1}{8}$th of the diameter.

Mr. Dhar.—I have made 8″ mirrors with 1″ thickness.

The President.—Was it a success ?

Mr. Dhar.—Yes, quite.

The President.—I think that a $\frac{1}{6}$th thickness is pretty safe. Of course it can be made much thinner. Mr. Davies ground 12″ mirrors only $\frac{1}{2}$″ thick, but in this case it was a plane mirror. An amateur would find a $\frac{1}{6}$th thickness the best.

Mr. Dhar.—If the President would allow me I should like to send in a paper on the subject.

The President.—We should be very glad to receive your paper.

A vote of thanks was accorded to Mr. Buchanan for his interesting paper.

The next paper of the evening was read by Mr. Banerjee on the lunar ring plain Gassendi, who also showed some lantern slides to illustrate his remarks.

The President.—I should like to ask Mr. Banerjee one or two questions. I understand his process is that, when he has supposed his observer in the ring plain, he imagines himself to take a sharp knife and cut the mountain ring and spread them out in a line. Might I also ask whether you adopt a practical standard scale when you draw these mountains in your diagrams ? Are those heights to scale ?

Mr. Banerjee.—They are to scale.

In returning a vote of thanks to Mr. Banerjee, the President remarked that this was the third paper submitted by him, and that he had very ably dealt with a most interesting subject.

Mrs. Tomkins next read a paper on star photographs, explaining her remarks by the aid of some lantern slides taken by herself.

Col. Lenox Conyngham.—I would like to know if any attempt was made to determine the magnitude from these photographs.

Mrs. Tomkins.—Yes ; but the photographs were taken at too long intervals to give good results on this star—Algol.

The President.—They ought to be measurable, I think. When you are measuring the magnitude on an ordinary star, you judge your photographic magnitude by the diameter. If you trail a star, the width of that trail ought, I think, to give you a measurement of the magnitude. Of course you will have to make the usual reduction so as to be able to compare one plate with another.

Each variable star, taken on two plates at different times, might be affected by clouds developing, etc., and the trail of a fixed star would not always be of the same width ; but it should be of the same relative width to other stars in the plate, and this for bright variables will give a means of estimating the photometric magnitude. It is a question of interest to amateurs with cameras. These plates were taken not near enough together. A series of observations taken for, say, three hours would be interesting.

Mr. Bhima Sena Rau.—What are the dots just off the ends of the trails ?

Mrs. Tomkins.—They are for the identification of the stars. After exposing for the trail you put the cap on the lens and wait a short space of time and then give a second short exposure. This prevents any confusion of stars with defects in the plate.

The President.—It is most important to have some method of identification. One particular instance I remember. I was photographing an eclipse of the moon, and I got a most interesting object on the plate which I sent for opinion to a well known astronomer friend of mine. He suggested a hole in the dark slide and I found he was right !

Mr. Ramaswami.—Do I understand that the camera is mounted ?

The President.—Just an ordinary camera screwed on a support. There is one point which might be of interest to members, and that is the method of focussing.

The President then demonstrated his remarks by drawings on the blackboard.

The President next showed some lantern slide pictures received from the Kodai Kanal Observatory of the sun during a recent magnetic storm ; calling upon Dr. Harrison to kindly explain and comment on the pictures.

Dr. Harrison.—The Zeeman effect shown in the spectrum of those portions of the Sun's surface in the immediate neighbourhood of a spot, is a splitting up of what is normally a single line into two or more lines. The effect can be accounted for by assuming the atoms of matter to be associated with small electrically charged particles (electrons) of definite mass, the orbital vibrations of which give rise to light. Any particular wave length (and therefore any particular line in the spectrum of a glowing gas) is associated with a particular configuration of certain groups of electrons. A magnetic field will, in general, disturb the configuration, giving rise to one or more different periods of vibration, which is made evident to us as a doubling or trebling of what was originally a single spectral line. In the slide shown on the screen, the line of Calcium in the immediate neighbourhood of sun spots (which are always believed to be the seat of intense magnetic forces) is seen to be doubled in the one case and trebled in the other.

The President.—I think we are very much to be congratulated on having Mr. Evershed as one of our members to send us down these series of slides ; this makes the second instalment he has sent us. He has been a very good friend to the Society, and we all very much appreciate the privilege of seeing these wonderful pictures which many of us in India could not hope to otherwise enjoy. Mr. Evershed has now been appointed Government Astronomer and Director at the Kodai Kanal Observatory, and I am sure that the Society sends him its heartiest congratulations and thanks. This was unanimously agreed to, and a vote of thanks was returned to Dr. Harrison for explaining the slides.

Some photographs of the Orion Nebula were then shown, and one taken recently with the Presidency College instrument by Mr. Woodhouse. The definitions of Mr. Woodhouse's slide was much admired, the image of the Trapezium and Nebula being especially clear. A vote of thanks was returned to Mr. Woodhouse.

At the conclusion of the Meeting, Mr. Saroda Charan Mittra suggested that His Highness the Maharajah of Jaipur—who has been connected with Astronomy from the earliest times, and was in Calcutta—might be approached to see if he would join the Society. The suggestion was accepted and Mr. Mittra was asked to approach His Highness on the subject.

The Meeting was then adjourned to the 28th of March 1911.

Report of the Special General Meeting held on Tuesday, the 28th February 1911, at 4-45 p.m.

The Meeting was called in order to amend Bye-laws Nos. 4 and 57, and to make new Bye-laws for the regulation of the Library.

After discussion, the Bye-laws as below were passed :—

New Bye-laws.

1. Subject to the direction of the Council, the Library shall be under the management of a Committee of three members appointed by the Council, of whom the Librarian shall be one.

2. When books are required for the Library, a list of such works as are suitable shall be made by the Library Committee, and these books, after report by the Treasurer as to the funds available, shall then be purchased by the Librarian. Members may suggest to the Committee suitable books for the Library.

3. On receipt of books for the Library, the Library Committee shall in case of each work decide, before they are placed on the shelves, whether such work shall be for reference in the Library only, or for circulation under the rules below.

4. The Librarian shall then add the work to the Catalogue and enter it in his library accounts, after which it shall be placed on the shelves.

5. No work of reference or periodical shall be removed from the Library.

6. No person who is not a member of the Society shall be permitted to borrow any book from the Library, or to have access to the Library, except with the permission of the Council.

7. If a member is desirous of borrowing books from the Library, he shall deposit the sum of Rs. 5 and shall sign a library card assigned to him by the Librarian. His signature shall signify his adherence to these rules and shall be kept by the Librarian. The deposit shall be refundable to the member when he ceases to borrow books from the Library, subject to his complying with Rules 9 and 12 below.

8. Books may be obtained from the Library on application to the Librarian, either personally at the Library or by written application.

9. Members who have books forwarded to them by post must remit to the Librarian, on receipt of the parcel, stamps to cover the cost of packing and carriage to them, and must prepay the carriage when returning the volumes. All books returned by post, etc., must be carefully packed. The receipt of the books should always be acknowledged, and on their return the Librarian should be advised of their despatch. (Members may deposit with the Librarian a sum of money not less than Re. 1, which will be used in defraying packing and carriage charges until expended.) The parcels shall be registered, acknowledgment prepaid both ways.

10. A member may only borrow one work at a time.

11. No work borrowed from the Library may be retained longer than 15 days from the date of receipt. If, however, no application for it shall have been made by any other member, the loan may be renewed for a second period of 15 days.

12. Any member borrowing or making use of a book or other property of the Library shall be responsible for it in case of loss or damage. If lost, the book shall be made good by the borrower, or in case of damage he shall be liable to pay the cost of the repairs to the satisfaction of the Council. Any property shall be considered as lost which is not returned within one month after the Librarian has made application for it. The term "borrower" in this rule includes all persons making use of the Reading Room or Library.

13. Books or other property of the Library in the possession of any member must be returned so as to reach the Librarian on or before September 15th in each year, and no book, etc., may be borrowed between that date and September 30th.

14. No unbound periodicals may be taken from the Library.

15. Every member who shall have transgressed any of the above regulations shall be precluded from borrowing any book from the Library until he receives the special permission of the Council.

16. A register shall be kept, in which shall be entered the title of every book borrowed, the name of the member borrowing the same, and the date on which it is lent, and an acknowledgment in writing shall be given at the time of borrowing any book from the Library; and on the return of

such book the Librarian shall insert opposite to the entry the date on which the book has been returned, and give in writing an acknowledgment of its return. And if on the return of such book the Librarian shall perceive that it has sustained any damage during its loan, he shall make a note of the particulars and report the same to the Library Committee.

17. In place of every book removed from the shelves, a card or board shall be substituted, on which shall be written the name of the borrower and date of issue.

Modifications of Existing Bye-laws.

Bye-law No. 57.—For the present Bye-law substitute :—

"The common Seal of the Society shall be a representation of the constellation Scorpio above observatory set among palm trees, the whole surrounded by a border of lotus flowers with the words and figures 'Astronomical Society of India, 1910.'"

Bye-law No. 4.—From the first line of this Bye-law strike out the word "Treasurer," and after the word "Sections" in line four add the words "the Treasurer."

Grinding a 16-inch Speculum by hand.

By W. E. Buchanan.

Having recently completed a 16″ speculum, a few notes may be of interest to members who make or contemplate making their own mirrors—for Newtonian telescopes.

The disc of glass was procured from Chance Brothers, Birmingham ; it was $2\frac{1}{2}''$ thick and weighed some 45 lb.

The tool was of cast zinc and of the same thickness as the speculum.

Zinc was selected as being easy to cast and turn, but iron I consider better.

The focal length having been decided on (in this case 96 inches, or 6 diameters) two templates were made from sheet glass, by fixing an ordinary diamond glass cutter at the end of a long rod suspended to a beam.

The distance between the diamond and the point of suspension was 192 inches, and this is the radius of curvature or twice the focal length.

The speculum was then hollowed out to the required curvature by grinding it (face up) with a lead tool about 8″ diameter, 40 hole carborundum and water being used as the abrasion.

When the hollow corresponded with the template which took some 6 or 8 hours work, the zinc tool was taken in hand and faced up in a lathe, and then turned and scraped convex to its template.

The tool was then fixed face up on the top of a circular iron drum about 2′ 6″ high, and the speculum ground against it in the following manner.

The tool had carborundum smeared evenly on its face, and the speculum was placed gently face down on it. The speculum was then ground backwards and forwards with strokes of varying lengths, it being slowly revolved in the hands at the same time.

But the tool being a fixture, it was also necessary to walk round it about once in 100 strokes, so that the grinding would be uniform.

After the rough grinding was done and speculum and tool touched each other all over, the grinding was continued in grades ending up with 120-minute emery, *i.e.*, extremely fine particles of emery which are contained in the water syphoned off from a glass jar of emery and water which has stood for 2 hours after being stirred up.

At the completion of the fine grinding it was possible to read the smallest print through the mirror.

The polishing was done in a somewhat unusual way; with a facetted pitch tool and jeweller's rouge, but with the polisher of only 6½″ diameter.

It was found that with a full size polisher there was a tendency to stick and the work was very hard, so as an experiment the writer started polishing with mirror face up and the small polisher mentioned.

Probably most speculum workers would be horrified at this unconventional method, but, as a matter of fact, the curve was in some ways under better control than when using a full-sized polisher.

The first test (on the Foucault method) showed the mirror to be slightly hyperbolic, and this curve varied very slightly right through the polishing process, and there was no tendency to the "rings" which are sometimes such a source of trouble.

The final curve still showed a slight tendency to the hyperbola, but I considered it advisable to do no more till

star tests were made, and these I hope to carry out soon. In the space of a brief paper like this, it is of course impossible to do more than touch on the subject of speculum grinding.

But those who wish to learn more should refer to the *English Mechanic*, which has much useful information on this fascinating and exasperating pursuit.

In fact it was from articles in that Journal by our President, Mr. Tomkins, that the writer made his first speculum some 10 or 12 years ago.

Crater Gassendi as viewed by an observer on the Moon.

By U. L. Banerjee, M.A.

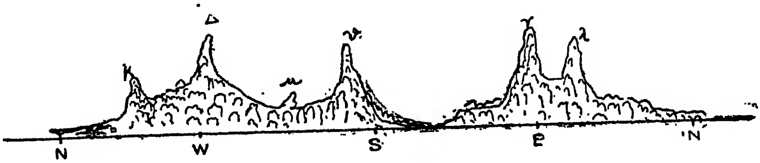
This evening we shall see what view our imaginary observer on the Moon will have of the Crater Gassendi, its surrounding walls and mountain peaks, standing at different places on its surface.

This crater is situated between +14°-15′ and +18°-13′ Lat. and —38° and —41°-10′ Long. It is a fine walled plane nearly circular in shape, having a diameter of 553 miles and an area of about 2,000 square miles. It is surrounded by a mountainous wall varying in height from about 9,600 to 500 feet over its interior. Beyond these walls is Mare Humorum, enclosing the plane on its south, the bed of which is 2,000 feet below the interior of the walled plane.

On its east wall is a long elliptical depression, on the south and north ends of which are situated two lofty mountain peaks γ and δ respectively about 9,600 and 9,000 feet high. Running northward, the wall is crossed by two deep passes on the north-eastern border. It then slopes down to the north to open out into the interior of a large ring plane, which forms a sort of spoon-shaped loop, surrounded by walls reaching to a height varying from 10,000 to 13,000 feet. Beyond this, on the north-west, the walls seem to have fallen outwards on to the surface to form a great mass of débris. At κ on the north-western corner the walls assume a height of 6,300 feet, and then terminate into a lofty peak λ 9,270 feet high on the east. It then again slopes down southward to a height of 3,700 feet at μ attaining again a height of 9,000 feet at υ on the south. Here the walls suddenly part to form a deep pass scarcely 500 feet high,

running into Mare Humorum. Beyond this pass the walls again gradually reach a height of 2,000 feet, ultimately culminating in the loftiest peak γ on the east.

The view of the mountain heights may be graphically shown as below by spreading out the walls in a straight line.

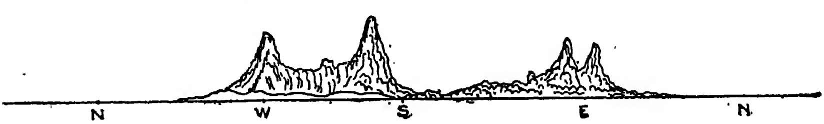


In the centre of the crater there is a mountainous group consisting of 3 considerable masses divided by deep valleys, the western mass being the loftiest. On the south end is the peak α 3,800 feet high, while on the north is situated another peak β 4,000 feet high. Two more peaks on the north-west of α reach a height of 3,500 feet. There is a central mountainous mass on the east, consisting of three more peaks, of which the northernmost one σ is the loftiest.

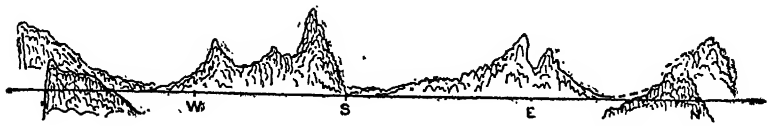
There are certain small craters scattered in different parts of the plane, of which the prominent ones are one on the south-west, another a little on the north of it, and the third one on the east of the central mountainous mass.

The bed of the crater is not at all level. Besides the mountainous elevation in the centre, and several craterpits, there are a number of detached ridges running particularly north to south, and a very delicate system of rills which are nothing but long cracks or narrow chasms several feet deep. These are extremely delicate formations, some uniting together to form a collective system, while others appear entirely independent; they sometimes run in straight lines, passing through craterpits, and their average width varies from one to two miles.

As the bed of the crater is not uniformly level, the observer cannot always have a full view of the mountainous walls enclosing its plane. When he takes his position at the extreme edges, the walls opposite will always be obstructed by the central mountainous mass. Thus when he stands on the edge of the pass interrupting the walls on the south, instead of seeing the mountainous range as shown below,

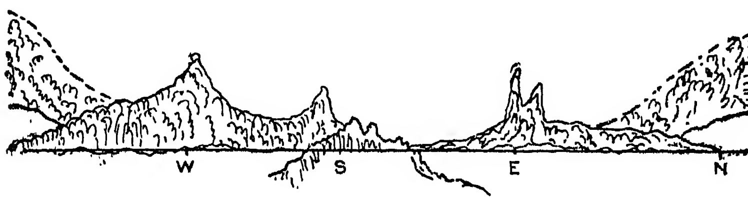


he will see it as



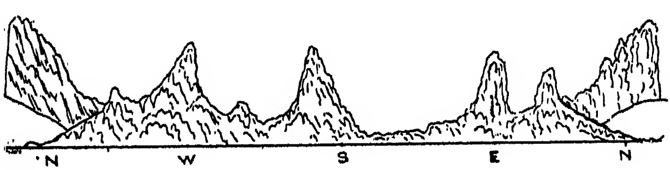
the portion marked a little below being the central mountainous mass, the peaks of which are 3,500 to 3,800 feet high, of which about half only will be seen, which, at its back, will come out as a relief to the mountain ring wall of the ring plane on the north, which is 10,000 to 13,000 feet high, of which 2,000 to 5,000 feet will be seen.

Moving to the north edge he will see the mountainous range as shown below:—



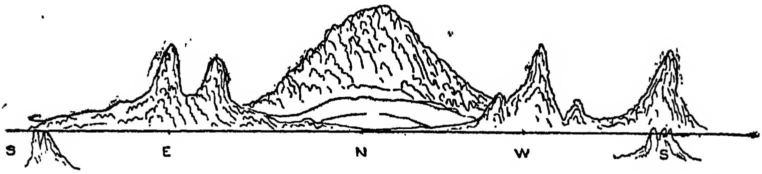
The portion marked separately below will be the view of the mountain mass at the centre, and that marked a little above is the mountain wall of the ring plane on his back.

A most picturesque view he will get of all the walls, crater-pits, ridges and the rills, if he can stand on the top of the peak α in the central mountains. From the base of the peak, he cannot see 2,000 feet of the walls from their bottom, but as he climbs the peaks higher and higher, he gradually gets the entire view of the walls, and when standing on its top he sees the different peaks, as well as the mountains around the ring plane on the north. The view will be as shown below:—



If he now shifts his position to the top of the northernmost mountain wall of the ring plane, which is 13,000 feet above its interior, and looks on the bed of Gassendi and its walls, he will not miss a single peak, and the whole mountainous chain will stand as bold relief against the dark sky.

Putting north in the centre of our diagram, we may depict the view as shown below :—



From here he will catch a most picturesque view of the effects of the sunshine on the mountain tops and the inner bed below during the lunation period. As the sun rises from the west, he catches the beam of light first, while the bed of Gassendi and its surrounding walls remain immersed in total darkness. Gradually the sunlight falls on the mountain peaks, and afterwards on the walls on the west, which cast their shadows on the interior. As the sun rises higher and higher, the mountain peaks on the eastern walls, as well as on the central mountainous pass, come out prominently, and the shadows of the western wall becoming shorter and shorter, display the interior of the plane, with its numerous ridges, rills and craterpits. The western side of the walls and ridges still remain in darkness, which stand in strange contrast with the bed of Mare Humorum, which has by this time got the full sunlight. As the sun becomes vertical, the craters and ridges stand out very prominently, showing the effect of the subterraneous forces on the face of the moon during its formation. As the sun goes down on the east, the western walls gradually lose its light, and the shadows of the eastern wall cover the inside of the crater. Unlike our 24 hours, full 30 hours are taken by the sun in completely disappearing from the view of our observer, and he will have work for the whole period (if he can wait at all) to have the full view of the sunshine. As the sun goes down the horizon the whole scenery becomes immersed in pitch darkness, there being no atmosphere, or any appreciable one, to give him an hour's twilight to find his way down the mountain side.

Simple Method of Star Photography.

By Mrs. Tomkins.

To any one with only a camera in their possession, star photography hardly seems to suggest itself, but being desirous of getting some observations, this seemed to offer a possible method, though no doubt to those with better apparatus it may appear rather the contrivance of an

amateur. Still it may interest some of those present, whose aspirations are small, to have a short account of how one was used for that work.

The camera happened to be a full plate, but a quarter plate instrument could be used in the same way, and being smaller would be easier to manage. To an ordinary strong framework, such as a tall stool, a board is attached by a hinge at the back to the edge of the framework, and in front a long moveable slot of wood moving up and down is fixed by a screw at any desired elevation. On this board, through a small hole in the middle, the camera is screwed by its own tripod screw in the usual way, and the apparatus is complete.

Take this out on a dark night, and by the aid of our star charts, having located the desired constellation and star or group to be taken, point the camera in that direction, sighting over the top of it, and move the board, on which is the camera, slowly up and down until some big guiding star is on the ground glass. Then change the ground glass for a piece of plane glass—a cleaned negative answers the purpose well—and by the aid of a focussing glass get the focus sharp and screw up tight in that position. This place can then be marked on the wood with a pencil and thus save trouble in finding it another night. Here a word on the focussing may be useful, as it requires to be very sharp. To get this, take beforehand the piece of plane glass and make a small scratch on one side of it. Hold it in front of a light, and look at the scratch from the other side of the glass with the focussing glass and regulate this up and down carefully till the focus is quite sharp, and keep the focussing glass in that place. It will then be ready to use on the stars.

Proceed in the usual way to put in and expose a negative, which will require to be backed to prevent halation. Keep the lens open as long as considered necessary, say three minutes, taking care not to shake the apparatus once the cap is off. The result will be trails of stars. The particular series of negatives referred to failed in their object, as they were taken at too long intervals apart. The idea was to photograph the constellation Perseus in order to observe the variation of light of Algol, β Persei. It seemed feasible that if a series of negatives were taken and the width of the trail compared with the other trails on the same negative, whose brightness does not vary, and these compared after reduction with the other negatives, a light curve could be found. Algol being well known, its curve is already well determined, but the method might be at least tried and the results would be interesting.

To measure the trails a micrometer is required, and after the measures have been reduced to a common denomination, they can then be compared. On the negatives it is not the length of the trail that is to be observed, but the width, and the brighter stars therefore make wider trails, the length being due to the length of time of exposure. The width again varies according to the colour of the star, a red star making a narrower trail than a blue one for instance, but these would be details for particular cases. Also a clear or cloudy night makes a difference in the relative size of all the trails, as an illustration a slide put on the sheet showed where a cloud passed over during exposure, partially obscuring the stars for a short time, and thus lessening the light as shown by the sort of dumbbell shape of the trails. Perhaps this can hardly be called deep science, but it forms quite an interesting method of using a camera.

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the month of April 1911.

Sidereal time at 8 p.m.

	H.	M.	S.
April 1st	8	35	19
,, *8th*	9	2	55
,, *15th*	9	30	31
,, *22nd*	9	58	7
,, *29th*	10	25	43

From this table the constellations visible during the evenings of April can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

		H.	M.
April 6th	First Quarter .	11	25 a.m.
,, *13th*	Full Moon . .	8	7 p.m.
,, *22nd*	Last Quarter .	0	6 a.m
,, *29th*	New Moon . .	3	55 a.m.

Meteors.

Date.	Radiant. R. A.	Radiant. Dec.	Character.
April 20-23	189°	−31	Slow; long.
20-21	261	+36	Swift; bluish white.
20-22	271	− 2	Swift: streaks.
20-25	218	−31	Slow: long paths.
30	291	+59	Rather slow.

Planets.

Venus—Is an evening star. It sets 2 hrs. 29 mins after sunset.

Saturn.—The position of this planet on 15th of April at 8 p.m. will be R. A. 2 hrs. 24 mins. 25 secs. Dec. 12°-3′-17″ N. Time of its setting is 6 hrs. 53 mins. p.m.

Mars.—The position of the planet on 15th of April at 8 p.m. will be R. A. 21 hrs. 47 mins. 59 secs. Dec. 14°-44′-52″ S. The time of its rising will be 2 hrs. 16 mins. a.m. on 16th April.

Jupiter.—The position of the planet on 15th April at 8 p.m. will be R. A. 14 hrs. 38 mins. 29 secs. Dec. 14°-0′-1″ S. The time of its rising will be 7 hrs. 6 mins. p.m.

The Sun.

A total eclipse of the Sun will take place on April the 28th. The eclipse will be invisible in this country. The line of central eclipse traverses the Pacific Ocean, and the most suitable spot for observation will probably be the Friendly Islands. A partial eclipse will be visible in Australia.

Extracts from Publications.

Mr. E. W. Maunder, at the Meeting of the British Astronomical Association, said that, with regard to the question of the brightness of the corona, it had occurred to him in three total eclipses to try to note the time after sunset when the illumination was equal to the illumination during mid totality. The first time he did so was in India in 1898, two or three days after the eclipse. Being out in the open just after sunset, it struck him that the phenomena of the fading light were very like what he had witnessed during totality, and he carefully noted the time when he thought the illumination was just about equal to what it was at mid totality. Curiously enough, at the same time Mr. Backhouse, on the

other side of India, had been taken with the same idea, and he also made observations and the two agreed, he believed, within about half a minute of time. Then in the Algerian Eclipse of 1900 he suggested to several observers that they should make similar observations, and here, again, although it might have been expected that the observations would be extremely rough, yet they proved to be very convenient.

In Mauritius, 1901, they repeated the same observations. These four or five observers made independent estimates and they agreed very closely.

Practically it came to this, that the illumination of the sky during the total eclipse was about equal to that when the Sun was seven degrees below the horizon ; which would show that there was a very appreciable amount of illumination from the corona in a total eclipse.

[*Journal of the British Astronomical Association.*

The following note on Star Drift by F. W. Henkel, F.R.A.S., appears in the Journal of the British Astronomical Association :—"Some time ago Mr. Hardcastle, in an interesting address to the Association (January 1910), alluded to the phenomena of migrating stars, referring specially to the five well-known stars in the Great Bear. β, γ, δ, ϵ and ζ Ursæ Majoris, as having nearly the same proper motion, which was first pointed out by Proctor about 1870, though Dr. Ludendorff has since found that the proper motions are not to be considered exactly parallel, but all as diverging from the same point of the sphere. He mentioned that Sirius, too, has been shown by Lieut. Hertzspring to be a member of the same family. It may interest some to give here Dr. Ludendorff's list of stars, which he considers are also members of the group in addition to Sirius and the five stars in Ursa Major. They are β Aurigæ, 37 Ursæ Majoris, δ Leonis, and α Coronæ Borialis. Thus ten stars are now known to be connected in this way.

These stars not only drift together, but they also lie approximately in one plane, and nearly in a right line. The convergent point is given by Dr. Hertzspring as R. A. 127°·8 Diel + 40°·2, or in a vacant region of the Constellation Lynx, south of the fifth magnitude star 31 Lyncis. The speed of the system referred to the Sun is given by him as about 18·4 kilometers per second.

Dr. Ludendorff's detection of α Aurigæ and β Coronæ as members is given in Astronomische Nachrichter, No. 4376. See also Astrophysical Journal, 1909, September."

[*Journal of the British Astronomical Association.*

Messrs. Walmesly and Chant write to the *English Mechanic* as follows :—" At five o'clock on February 11, from the summit of Goat Fell, some 1,500 feet above sea-level, we saw below the Sun, which was then about three or four degrees above the horizon, what appeared to be a portion of the solar spectrum, crossed by bright and dark lines. So far as we could judge, the lower end of the spectrum appeared to rest on the sea, which at the time was obscured by a bank of fog. Two bright and two dark lines were prominently visible, and several others were suspected. A vertical bright ray was also visible running down the middle of the spectrum. The colour was orange-yellow, and the dispersion apparently very great. The width of the spectrum corresponded exactly with the diameter of the Sun. Wisps of cloud or fog were seen drifting across the upper portion of the spectrum, and ultimately obscured it. The phenomenon disappeared at 5 h. 4 m., reappeared for a minute or so about 5 h. 8 m., and then finally vanished. It was as sharply defined as if seen through a spectroscope. The sun was at the time shining brightly in a clear sky, immediately above a dense bank of cloud.

Our theory is that a rift in the cloud bank immediately under the sun allowed a ray of sunlight to fall on the sea below, and the sea being covered by ripples, acted as a huge diffraction grating. From a different elevation we should probably have seen a different portion of the spectrum. We should be glad of any information on the subject.

[*English Mechanic.*

Regarding Mr. Espin's Nova, Mr. Monck writes :—" I would have thought that the fact of a star having been previously seen in the position of Mr. Espin's Nova tended to establish the nebulous origin of new stars. The star was previously there ; but it has received a great accession of heat and light. What is the explanation ? Rushing into a nebula seems the most natural conclusion. It is true that no nebula may have been seen previously ; but new joint nebulæ are lines constantly discovered, and the list is probably still far from complete. On the other hand, though one small star was noticed, no companion star was previously seen ; but I must here admit that, with objects at so great a distance, it is probable that no telescopes in existence would separate two colliding stars for some years before the collision. But stars are distributed so sparsely through space that collisions between two of them must be of very rare occurrence, while, on the other hand, nebulæ occupy such extensive spaces that it seems

almost certain that stars must occasionally rush into them. I do not profess to be an authority on what would occur if there were a grazing or even a direct collision between two stars; but if a star of any considerable size rushed into a tenuous nebula I would expect to find a mere surface-heating which would soon die away when the nebula was cleared, while the shock of a collision between two large solid bodies would penetrate more deeply and take longer to die away. The two stars, however, would not improbably be surrounded with gaseous envelopes which would bear the brunt of the collision.

[*English Mechanic.*

The following are some remarks on the standard measure in possession of the Royal Astronomical Society made by Mr. H. B. Darling and others at a meeting of the Society.

It is probable that even at the present day there are very few standard measures which are entitled to be called standard scales; and this fact lends a certain importance to the Society's scale, specially as Baily's comparisons were made with extreme care and accuracy.

In 1907 a number of comparisons were undertaken by Major MacMahon, Deputy Warden of the Standards, at the request of the Society, in order to determine whether the length of the centre yard and the relative lengths of its three component parts had altered during the period of more than 70 years which has elapsed since Baily's comparisons. The scale was compared with the official bronze bar of the Board of Trade known as SS, the length and sub divisions of which are accurately known in terms of the present Imperial standard yard. Major MacMahon found the centre yard to be 0·001050 inch longer than the present Imperial standard yard. Baily had found it to be 0·000376 inch longer than the Imperial standard yard of his day (Bird's standard yard of 1760), the length of which cannot be precisely expressed in terms of any existing standard, as it was destroyed in the fire at the Houses of Parliament in 1834. Airy has, however, referred to comparisons of the centre yard made about 1851-5, which showed that its length was 0·000420 inch greater than that of the present Imperial standard yard. The total length of the centre yard would accordingly appear to have increased relatively to the Imperial standard yard by 0·000630 inch since 1851-5. The lengths of the sub divisions were, however, found to bear the same ratio to the length of the centre yard as they did at the time of Baily's comparisons, so that their values at

the present day could be obtained from Baily's results by multiplying by a constant factor.

The President—I have been much interested in Mr. Darling's account of our standard scale and of the recent comparison, as I have no doubt all the Fellows present have been ; but his remarks about the apparent changes of length of our standard bar lead me to ask whether it may not be possible to attribute some part of the apparent change to a real change in the standard yard itself ; it is impossible to say where the apparent change arises. Why should we depend for the accuracy of our standards on the constancy of length of pieces of metal ? Should we not refer all our measures to the wave lengths of the red line of Cadmium ? No doubt the Scientific Meteorologist of a hundred years hence will not refer his standard to our scale or to the present standard yard or to the irrido-platinum bar at Breteuil, but to the length of the latter as determined by Fabri and Perot in terms of the wave length of the red line in the spectrum of Cadmium. I would add that in my opinion the construction of this bar is not good mechanically, and specially the insertion of the palladium pins appears to me to be a not very good device ; but I need not say more from the Chair and will ask others to speak on this paper.

[*The Observatory.*

The Observatory has the following account by Mr. Hinks of his measures of the magnitude of the Nova in Lacerta given by him at a meeting of the Royal Astronomical Society. "What I have attempted to do is to determine the photographic magnitude of the star upon several nights ; and at once I came across the fact that Mr. Bellamy mentioned that the photographic magnitudes of the surrounding comparison stars are altogether discordant from the visual magnitudes of those stars as given in the Harvard A. G. Zone Catalogue or the B. D. One can get no sort of reconciliation between the two ; so that it seemed the best thing to do was to begin by determining the photographic magnitude for some ten stars round about the Nova, which I have done, and of which I give an account in the paper. I used half a dozen stars to give a zero of the magnitude scale, making their mean photographic magnitude equal their mean visual magnitude in the Harvard Catalogue. That zero was 8·65 ; and it was evident that the Nova was a magnitude or so brighter. No other star in the same field was as bright, so that my photographic magnitudes depend on extra polation, which always, of course, is exceedingly dangerous. The extra polation, however, was done in this way. I have

in the measuring machine at Cambridge a photographic scale which was made by giving a series of exposures on the same star in the ratio $\sqrt{2\cdot5}$, the idea being that if 2·5 were the right ratio (which we know it is not photographically), one would get the scale interval half a magnitude. I have made two attempts to get the ratio of that magnitude scale. First, I used the Pliedas Series measured by Professor Schwarzschild in extra focal images. In that way I got two scale intervals (intended to be half magnitudes exactly), equivalent to 0·88 instead of 1. In order to get a check on that value, I reduced the same measures with Professor Pickering's photographic magnitudes of Pliedas stars, and my result was 0·65 instead of 0·88, a very serious discordance. To check that, I then measured up a number of fields of long period variables with the magnitudes given in the Harvard "Annals," Vol. 37, that gave 0·71. Time was pressing and I could not stop to discover what was the cause of that discrepancy between the ordinary results and the extra focal results ; so for the purpose of this paper and as a preliminary I adopted 0·69 as the value of two scale-intervals.

Reducing the differences of Nova and comparison stars with that scale value, I get a series of magnitudes which are given in detail in the paper results I need not trouble you with now. But I should mention that there are two sets of plates : Ilford Monarch and Wratten and Wainwright's Panchromatic. One expects of course, as it is such a red star, that one would get brighter photographic magnitudes from the Panchromatic plates than from the others, and strange to say that turns out to be the case! On January 1, 5h. 3, the Monarch plates give with my assumed zero 7·74 ; the Panchromatic plates give 7·42 ; so that the Nova is a third of a magnitude brighter on the Panchromatic than on the Monarch. On January 6, 6h. 4, I obtained another Panchromatic plate ; and that gives me the magnitude of 7·41. Thus there did not seem to be much change of magnitude in these five days ; but I must say that is contrary to the visual impression. A Monarch plate taken January 7th gave me photograhpic magnitude 7·74. So that the photographic evidence, so far as it goes, suggests that in the 5 or 6 day intervals the magnitude of the Nova did not change at all. But I am bound to say that the perfect concordance of these measures is hardly warranted by the individual results. which you will find tabulated more in detail in the paper. I hope that some of the photographic magnitudes of the dozen comparison stars obtained may be useful to other examiners of the Nova.

Notices of the Society.

Election of Members.

The attention of members is invited to Bye-law No. 14, regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherjee.

The Library.

A subscription list for the furnishing of a Library has been opened, and a good many members in Calcutta have put their names on it. The Library is available to members both in and out of Calcutta, and members who have not already done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

A number of books have already been received and can be borrowed by members in accordance with the Bye-laws in another part of this JOURNAL.

The books available can be ascertained from the Assistant Librarian and a catalogue will issue shortly. The reading room of the Society in the Imperial Secretariat is now opened for the use of members daily from 5 to 7 p.m. except on Wednesdays and holidays, and from 3 to 5 p.m. on Saturdays unless that day is a holiday.

Subscriptions.

Some of the subscriptions are still due for the current session from members. Those who have not yet done so are requested to remit the amounts to the Treasurer.

The Treasurer will also be glad to receive those donations promised for the Library and quarters which have not already been paid, as the Council wish to take full advantage of the promised assistance as soon as possible during the present session.

Classes for Beginners.

The Council have arranged to hold a series of four classes for beginners in Calcutta, to enable those who wish to learn the rudiments of the science and how to use their Star Charts to do so. Mr. B. M. Rakshit, late of the Alipore Observatory, has kindly consented to hold the classes, and the names of those who wish to take advantage of the classes should be sent to him at 77-3, Musjid Barry Street, Calcutta, or to the Secretary, Mr. P. N. Mukherjee, without delay.

The ordinary meetings of the Society will be held on the following dates :—

1911.

March 28th	May 30th
April 25th	June 27th

The meetings will commence at 5 p.m. and, until further notice, will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

(2) *Secretary* (*Scientific*) . W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.

(3) *Do.* (*Business*) . P. N. MUKHERJI, M.A., F.S.S., Imperial Secretariat Buildings, Calcutta.

(4) *Treasurer* . . . U. L. BANERJEE, Office of the Acctt. General, Koila Ghat Street, Calcutta.

(5) *Librarian* . . . ASHUTOSH MITTRA, M.A., 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.

(6) *Editor* . . . J. J. MEIKLE, 8, Hastings Street, Calcutta.

(7) *Directors*:—

General Section . . DR. E. P. HARRISON, Presidency College, Calcutta.

Lunar Section . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

Meteor Section . . B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.

Variable Star Section . LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., Dehra Dun.

Photography . . R. J. WATSON, 37, Park Road, Barrackpore.

Instruments . . . S. WOODHOUSE, 15, Wood Street, Calcutta.

The Journal
of the
Astronomical Society of India.

Vol. I.] SESSION 1910-1911. [No. 6.

Minutes of Monthly Meeting of the Astronomical Society of India, held on Tuesday, the 28th March 1911.

H. G. Tomkins, F.R.A.S., *President*, in the Chair.

The Monthly Meeting of the Astronomical Society of India was held in the Imperial Secretariat Buildings (ground floor) on Tuesday, the 28th March 1911, at 5 p.m.

The Meeting was opened by the President, who called upon Mr. Bannerjee, in the absence of Mr. Mukerjee, the Secretary, who had gone up to Delhi on duty, to read the Minutes of the last Monthly Meeting held on 28th February 1911. The Minutes were duly confirmed. At the request of the President Mr. Bannerjee next read the list of donations to the Library, and a vote of thanks was accorded the following donors:—

Prof. Emmanuelli .	A Treatise on the Total Eclipse of the Sun of April 1911.
Mr. Evershed .	An article on the Angular Speed of Rotation of a Long-enduring Prominence.
Dr. Lowell .	A Set of Transparencies of Mars, Jupiter, and Saturn.
Mrs. Tomkins .	Rs. 10.

The President announced that the following Societies and Observatories had put the Astronomical Society of India on their lists of exchanges, and a vote of thanks was duly returned to them:—

The Astronomical Society of Italy.
The Astronomical Society of Barcelona.
The Royal Observatory of Scotland.
The Vatican Observatory.

The President next read the names of the following members who had been elected at the last Council Meeting, and these were duly confirmed:—

(1) MR. SARAT CHANDRA BHATTACHARYA, M.A.; F.C.S.
(2) MR. RONALD SHAW.
(3) MAJOR E. L. PERRY, I.M.S.
(4) MRS. HARRISON.
(5) MR. SURENDRA MOHAN CHATTERJI, B.E.

New members were then admitted and welcomed in the name of the Society by the President.

The first paper of the evening was contributed by Mr. Rakshit, Director of the Meteor Section, on a table compiled by him for use with the Star Charts. Mr. Rakshit illustrated his paper by working out an example of the use of the table on the blackboard.

The President—The table is very handy and complete. The meridian being of course over your head from north to south, the table simply enables one to find out roughly the constellations which are in that region at a given time by direct reference to the Star Charts at any time of year.

Mr. Holmes—How are the Roman numerals arrived at; are they worked out ?

The President—The Roman numerals represent the hours of right ascension and are worked out from the data in the other columns. The right ascension is the position of the star, reckoning from the first point of Aries. The decision as to what number to put in each column is a matter of simple calculation and has been worked out by Mr. Rakshit. There is nothing new of course in the method, but it is a very handy table, especially for beginners, of whom there are a good many among our members.

A vote of thanks was duly accorded Mr. Rakshit.

Mr. Rakshit then read a paper on the Lyrid Meteor Shower, illustrating his remarks with lantern slides.

The President—This is a forecast of the shower that is to take place at the end of next month (April), and I hope members will take an interest in it, and that we shall get some results.

A vote of thanks was duly returned to Mr. Rakshit for his paper.

The next paper of the evening was read by Mr. Holmes on the Meteorite of the 24th of November 1910. The lantern slide pictures for this paper were unfortunately not ready for reproduction and will appear at the next meeting in April

Before inviting discussion on this paper, the President read a note on this meteorite, received from the Maharajah of Jalawar in November, which had already appeared in the Journal.

The President—It seems to me that from this information this meteorite must have moved in a line from north to south. It was seen at Jalawar and also at Mhow and Central India.

Dr. Harrison—Recalling the fact that meteors become luminous when the meteoric mass passes through the air, it seems possible that the air might itself become luminous from the intense heat engendered. Is it not possible that when the meteor itself has passed, the luminosity of the air might remain and thus account for the trail? Even in what seems to us still air, we know that there exist numerous slight air currents, and this would of course account for the zig-zag appearance of the trail.

The President—Will that account also for these extra bright spots on the photograph?

Mr. Simmons—With reference to the trail not starting from the top of the plate, I would suggest that this might be due to the angle at which the photograph was actually taken. It was of course taken after the meteor had itself actually disappeared. With regard to the zig-zag path of the meteor, we do hear that meteoric dust exists. Is it not possible that this heated dust may be responsible for this zig-zag appearance in this case?

The President—You mean that the dust is the result of the combustion of the meteor?

Mr. Simmons—I do not say it is so. I only make the suggestion.

The President—I certainly think it is likely. Could Dr. Harrison tell us if he thinks one could get a spectrum of a trail of the kind seen in the present instance?

Dr. Harrison—I think you might.

Mrs. Voigt—Did the meteor end at the place where it was photographed?

The President—I do not think so; from the accounts given it travelled on towards Central India. The trail left behind seems to have lasted about half an hour.

I think it possible that the meteor might have met with more resistance in one part of its course than in another, and that this might account for the bright patches in the trail, or they may be merely an overlap of the trail caused by air currents afterwards.

The President then showed a lantern slide picture of a photograph he had taken near Bannu, which showed a remarkable streak right across its face, and which might have been the path of a meteor.

The President—One of the best proofs we could have to show that the Society is combining together is the case of this meteorite of the 24th of November 1910. It indicates the importance of working together, and of any one who makes any observations bringing them before the Society.

A vote of thanks was duly returned to Mr. Holmes.

Dr. Harrison now read a paper on the testing of a Mirror, illustrating his remarks with lantern slide pictures and black-board drawing.

The President—There is just one practical point here that I should like to mention which Dr. Harrison did not. You have got to get hold of the right position in the focus for your screen. A good many years ago I read of a method in the *English Mechanic* and I have adopted it since. It is important to have your screen and your artificial star fairly near together. Now what I want to explain is this: You have your rays meeting at a given point—the focus—and you must see that your screen is at the same point. Now if your mirror is a perfect sphere, and if your screen is in focus, the whole of your mirror will darken at once when the screen is passed across from the left. If you bring your screen nearer to the mirror, it will cut out the rays one by one and the shade will come on from left to right. If you have your screen too far away from the mirror, the shade will similarly come on from right to left, so that if it comes on from right to left you are too far away, and if it goes on from left to right you are too near. You can thus get the exact position of the screen by experiment. Some people take the mean centre of curvature for the position of the screen. I think it would be better to take the centre of the rays from the outside zone to start with.

A hearty vote of thanks was returned to Dr. Harrison.

Mr. Sirkar next read a paper on Standard Time.

The President—This paper raises an important question whether Calcutta should adopt Standard Time, or why it should not do so. Of course there is the mercantile point of view to be considered in the question, and we might discuss this at the next meeting.

A vote of thanks was returned to Mr. Sircar for his paper.

The President then showed some lantern slide pictures of Mars, Jupiter and Saturn received from Prof. Lowell of the Flagstaff Observatory, America.

Mr. Holmes—I notice the dark rings round the Polar Caps. Is this supposed to be water ?

The President—Yes, I think so. I believe Prof. Lowell puts them down to the melting of the Polar ice.

A vote of thanks was accorded to Prof. Lowell.

The President—There are just two things which I forgot to announce—the first is that the Library is now open to members, and those wishing to remove books may send in their deposits to the Treasurer; and the second is that at the last Council Meeting it was decided to extend membership of the Society to people in foreign countries, and the Society would be glad to hear from members who may have any such names to propose.

The Meeting was then adjourned to 5 p.m. on Tuesday, the 25th April 1911, in the Imperial Secretariat Buildings.

Paper on Standard Time.

By C. K. Sarkar, C.E.

The question of a standard time has once more been brought to the fore by Reuter's message that the Republic of France has after all adopted the Greenwich time as the standard for their country, and the patriots have ultimately capitulated before the advance of the idea of uniformity in scientific methods. Attempts have of late been made to have a common standard of measurement of time, space and weight in all the civilised countries of the world.

The method of measuring time, or at least the primary one, was by watching the revolution of the heavenly bodies, such as the Sun, the Moon or the Stars. To a casual observer the diurnal motion of the heavenly bodies may appear to be uniform, but a close study at once reveals the fact that such a belief is an erroneous one. It is no easy task to measure the absolute length of time. The difficulty lies in fixing a common standard of measurement. For astronomical purposes, the standard is taken as the period that elapses from the culmination of one star to the culmination of the same star the next day. This is called a siderial day. The siderial day commences when the first point of Aries passes the meridian, and a clock correctly adjusted to siderial time will read 0 hrs. 0 mts. 0 secs. at that period.

It will be apparent to a careful observer that this standard, though suitable to astronomers, is not well adapted for regulating the ordinary functions of our life. The diurnal motion of the sun furnishes us with a more convenient standard for measuring the sequence in every day affairs of our life. We shall now try to understand how the two standards differ. If a star and the sun are supposed to be on the meridian on a day, on the day following the meridian will meet the star at the same place, but the sun will have advanced 59′, and the meridian will have to describe that arc before it can reach the sun; or in other words, the period that elapses from the transit of the sun any day to the transit of the sun the next day is longer than the period that elapses from the culmination of a star any day to the culmination of the same star the next day, by a period that the meridian takes to move through an arc of 59′ or by 3 mts. 56 secs. nearly. On account of the variable motion of the sun and the inclination of the axis of rotation of the earth to the plane of its rotation round the sun, the length of a solar day is not uniform throughout the year, and to regulate and adjust our clocks, the astronomers have to take recourse to the motion of an imaginary sun that is supposed to rotate with a mean uniform velocity.

The ancient Hindu astronomers at one time tried to have a standard for measurement of time by taking the motion of the moon as its foundation, and the lunar month was found to agree with the phases of the moon. This was not altogether satisfactory, and the solar day and month were next introduced. At a still later period endeavours were made to reconcile the two systems. All the systems are in vogue in different parts of India and Burma, but for all practical purposes a mean solar day is now taken to be the standard. But a considerable divergence still exists in the method of reckoning a day. The Hindus calculate their day as commencing from sunrise and ending at a period immediately before sunrise the next day; the Muhammadans, if I am not mistaken, measure a day from sunset to sunset. In all European countries a civil day commences from midnight, while an astronomical day is reckoned from noon, when the sun crosses the meridian. The question of adopting a universal day was discussed at the Washington Meridian Conference, but the great number of American and Continental astronomers expressed themselves against the change.

Simultaneously with this arises the question of fixing a point from which the lines of longitude are to be reckoned. In ancient India the longitudes were reckoned from Ujjain

or from Lanka or Ceylon. In all English-speaking countries longitudes are reckoned from the observatory at Greenwich, and all English charts or maps give the longitude so reckoned. The French astronomers and geographers reckon their lines of longitude commencing from the observatory at Paris, which is less than 10m. east of Greenwich. It was recommended by the Washington Prime Meridian Conference in 1884 to exclusively use the Greenwich Meridian. If we could agree to have a universal day commencing from an exact period all over the world, it will be one factor that will work towards the unification of human races.

During the Viceroyalty of Lord Curzon standard time was adopted for India. It was fixed at 5h. 30m. in advance of Greenwich time. India lies between longitude 67° E. and 98° E. approximately. This shows that when it is noon at Greenwich the local time at the easternmost point in India is 6-32 p.m., while at the westernmost point it is 4-28 p.m. The mean between the two is 5-30 p.m. This was probably one of the considerations for adopting a time 5h.30m. in advance of the Greenwich time as the standard for India. A difference of 5h. 30m. represents a difference of 82° 30′ of longitude. The standard time in India is the exact local time at all places situated on longitude 82° 30′ E. Jagadispur in the district of Azimgarh, longitude 82° 39′ 14″ E., Jaunpur 82° 43′ 38″ E., and Mirzapur 82° 37′ 23″ E. are the only places of any importance that are situated close to this line of longitude. The line passes through the western border of Chutia Nagpur, runs close to the town of Champa on the Bengal-Nagpur Railway, along the western border of the Orissa Tributary Mahals and to the east of Cocanada in the Madras Presidency.

For Burma, which politically forms a part of British India, a different standard has been fixed. This is 6h. 30m. in advance of the Greenwich time. Burma lies between longitude 93° E. and 101° E. approximately. Continuing our enquiry on the same line, we find that when it is noon at Greenwich it is 6-12 p.m. near about Akyab and 6-44 p.m. at or about Hsup Lwi on the Eastern border of the Southern Shan States. The mean of the two periods is 6-28 p.m. or 2 minutes behind the standard time in Burma as fixed by the Government of India. A difference of 6h. 30m. brings us to longitude 97° 30′ E., except Bhamo, 96° 58′ E., Moulmein 97° 39′ 47″ E., Amherst 97° 36′ 12″ E., Kalagouk Island off the coast of Amherst, longitude 97° 42′ 1″, and Yeh, longitude 97° 53′ 48″, head-quarters of a small township, there is no town of any importance close to this line.

With the growth of civilized methods of living, with national and international commercial relations springing up fast amongst us, for the management of a system of railways in a country, for steamer service, and for the Telegraph Department, a uniform standard time is almost a pressing need. When the construction of a railway line between India and Burma has come within the range of practical politics, it will be necessary to have a common standard of time between the two parts of the Empire.

The nautical almanac gives us a list of countries that have adopted standard time referred to the meridian at Greenwich. France has lately added its name to this list, and it seems to me that it is an example that might well be followed by Calcutta, where the existence of two systems of time gives rise to extreme inconvenience. I cannot conceive that difficulties would arise from such standardisation, though it is with some diffidence that I make the suggestion. It is with the purpose of getting the views of the members of this Society that I have introduced the subject.

A Meteoric Phenomenon.

By H. B. Holmes.

It was about last Xmas I noticed in the *Times of India Illustrated Weekly*, among the Snapshot Competition photographs, one that had obtained the first prize and which struck me as very extraordinary.

The title of this picture was "A Meteorite recently seen at Mhow (24th November 1910)."

Through the courtesy of the Editor of the *Times of India Illustrated Weekly*, I am now able to reproduce this photograph for your inspection, and I have been able to communicate with Sergt. A. Hempstead, Divisional Office, Mhow, who took the photograph, for further particulars of this very unique picture and his account, which to my mind makes the subject more interesting than I had anticipated.

When I saw the reproduction the first thought that came to my mind was how was it possible for any one to have been able to snapshoot a meteor in its flight. The next thing that struck me was that the meteor's path did not commence right from the top of the plate, but some little distance down, and it dissolved into nothingness before it reached the tops of the trees which showed out prominently in the foreground. Another more striking point was that it was contrary to all my ideas of what the path of a meteor would be,

even if one were lucky enough to be able to photograph it. My impression is that on a photographic plate the path of a meteor would be represented by a clean-cut line either straight or curved. The photograph represented the path zig-zag, and reminded one more of a reproduction of a flash of lightning. The sky, however, was perfectly clear, and there was no sign of any clouds. One very noticeable feature was the distinct deviation from the downward path some little distance from the starting point and the sudden termination in rather a bright spot.

I cannot do better than here reproduce Sergt. Hempstead's letter to me :—

"In reply to your letter of 13th March 1911, I take great pleasure in forwarding you the following information regarding the meteor referred to :—

"(A) About 5-50 p.m. on the evening of the 24th November 1910, there suddenly appeared in the heavens, almost immediately overhead, a very bright ball of fire (which appeared to the naked eye about the size of a cricket ball); it travelled at an enormous speed in a downward, south-westerly direction, leaving a very bright line of fire on the course travelled, and disappeared from sight; it did not appear to burst, but seemed to travel beyond the reach of the naked eye.

"(*i*) The time taken for its flight from when it first appeared until it disappeared from sight was about 2 seconds.

"(*ii*) The noise (slight) made by its flight was similar to that of a rocket or shell travelling through the air, and the smell like that of a broken flint.

"(*iii*) The atmosphere at the time appeared to be filled with a blue mist; there was no breeze blowing, and the sky was absolutely cloudless.

"(*iv*) The line of fire left by the meteor (as will be seen by the photo, which was taken 1½ minutes after its first appearance) wavered, 'it is presumed by the different currents of the air,' and gradually faded away until about 20 minutes after its first appearance, only a small cloud of fire was visible in the direction where the meteor disappeared.

"(B) I am enclosing two sketches, which may explain better the direction of the meteor's flight.

"(*i*) Sketch No. 1 is a portion of the sky, showing the direction the meteor travelled overhead.

"(ii) Sketch No. 2 is what appeared to me to be the direction it travelled across the earth; it would appear that, if the meteor did not burst, but kept on travelling, it would pass nearest the earth's surface, somewhere in the vicinity of Cape Town. On the other hand, it may have burst somewhere in Central India.

"(iii) I noticed some time back a letter in the *Pioneer* stating that a meteor was seen from Bhopal about the same time as this one appeared at Mhow. In that case the direction pointed out by me would appear correct.

"(iv) A reference to the small sketch incorner of Sketch No. 2 shows the angle at which the meteor appeared to pass the earth to be about 45° with the earth's surface at Mhow.

"(C) As regards the photo—

"(i) The camera used was an ordinary ½ plate folding Carbine, fitted with a Beck Rapid Rectilinear Lens, which was set at F-11, and a time exposure of 7 seconds given.

"(D) The negative, I regret to say, I prefer to keep in my own possession, as I value it very much, and it might be damaged in transit.

"I should be very glad to assist you in any way I can in giving any further information, and as I am interested in these things, would be much obliged if you could let me know the result of your meeting on the 24th instant."

From this letter, it will be noticed that it was not the meteor itself which Sergt. Hempstead photographed: the meteor had only been visible for about a couple of seconds and had disappeared 1½ minutes before the photo was taken. The picture is that of a trail of fire which was left behind the meteor.

I would draw special attention to the duration of this luminous aftermath.

Sergt. Hempstead has very kindly sent me two photographs. No. 1, he explains, is the actual representation of the fiery trail; No. 2 has been somewhat faked in order to bring out the same more prominently. He has also gone to a lot of trouble in making diagrams, which are here reproduced, showing the direction of the flight of the meteor and his position.

My intention in bringing this subject forward was to raise the question as to what was the path of a meteor in its

flight; was it, as I had always imagined, a clean-cut straight or curved line, or was it zig-zag, and if so, was there any explanation for it? Since reading Sergt. Hempstead's letter, it seems to me we have a very interesting and extraordinary phenomenon to deal with. With a meteor there is a fiery trail, but it vanishes as quickly as the meteor itself. What, then, is the explanation of this fiery trail; its duration of luminosity; its extraordinary zig-zag appearance, and the fact that it was not visible until the meteor had travelled some distance, and of its sudden termination; and what was the blue mist that was noticeable?

It would also be interesting to know whether this same phenomenon was noticed at Bhopal or elsewhere.

Meteors of April 1911.

By B. M. RAKSHIT.

In April there are six meteoric showers. The first is from 17th April to 1st May; the second from 18th to 23rd April; the third on 20th and 21st; the fourth from 20th to 22nd; the fifth from 20th to 25th; and the sixth on the 30th April. Of these the shower from 20th to 22nd is important and the meteors of it are swift. The radiant point is near the boundary of Lyra and Hercules, but the shower is known as the Lyrid shower. A short description of Lyra would, it is considered, be useful to persons watching for the meteors. Lyra is a small constellation, but it is widely known, as it contains the very bright star, Vega or α Lyræ. Those who do not know it may easily find it by the following method. The seven stars of the Plough in the Great Bear are well known. Join ϵ Ursæ Majoris the 3rd star in the handle of the Plough with the Pole star, and draw a line perpendicular to it from the latter star, and this will pass through Vega. Near this star will be found three double stars ϵ, ζ and δ Lyræ, which can be separated with very little optical aid. Below ζ and γ will be found β and α, of which the former is a short period, variable but always visible to the naked eye, as it never descends below 4·5 in magnitude. On the east of Vega will be found η and θ Lyræ, two small stars below the fourth magnitude. On the 20th April Vega will rise at 9h. 21m. p.m., and its angular distance at that time from the east point will be about 43° towards north. The R. A. and the declination of the radiant point of the shower are 18h. 4m. and 33° N. It is about 4° north of o Hercules, a star of fourth magnitude, and 43m. ahead of β Lyræ.

A Table for use with Star Charts.

By B. M. Rakshit.

In order to find out easily at any hour of the night on any day the constellations that are on the meridian, and hence those that are on the eastern and western sides of it, a simple table has been drawn up, and a part of it is shewn in this lantern slide. The method generally adopted for finding stars on the meridian at any hour is as follows: Suppose it is required to find the stars on the meridian at 8 p.m. to-day—28th March 1911. From the British Nautical Almanac, or the American Epheris and Nautical Almanac, or any other such book, take the siderial time at mean noon. The British Nautical Almanac gives the siderial time at mean noon at Greenwich for to-day to be 0h. 19m. 8·34s. The correction for reducing it to the siderial time at mean noon at Calcutta is 58·1s. Hence the siderial time at mean noon at Calcutta becomes 0h. 18m. 10·24s. The interval from mean noon to 8 p.m. is 8h. of mean time, which is equal to 8h. 1m. 18·85s. of siderial time. Therefore the siderial time at 8 p.m. to-day is 8h. 19m. 29·09s. Stars whose right ascensions are equal to this are on the meridian; but the table which has been drawn up, and part of which is shewn in this lantern slide, saves all these computations. First, I shall state generally the method of using it, and then take particular example. The hours of observation are given at the top of the table, and the first vertical column gives the date of observation, and the Roman numerals in the body of the table are the right ascensions in hours of time of stars on the meridian. Find the Roman numeral corresponding to the hour of observation as shewn in the top line, and the nearest day preceding that of observation as shewn in the first vertical column, and add 4 minutes for each day from that tabulated day to the day of observation. The hours and minutes thus found are the right ascensions of stars on the meridian. With this result refer to the star maps The stars which are in the vertical line marked with that R A. are on the meridian; those marked with greater R.A. are on the eastern side of the meridian, and those with less R. A. are on the western side of it. Let us take the same example as before: *i.e.*, what stars are on the meridian at 8 p.m. to-day—28th March 1911?

The hour of observation being 8 p.m., and the nearest tabulated day preceding the day of observation being 23rd March, we get from the table under 8 p.m. and against 23rd March the Roman numeral VIII hours. From 23rd to 28th there are 5 days; taking 4m. per day we get 20m. This

added to VIII hours, we have found from the table we get VIII hours 20m. This result agrees very closely with what we obtained before by the previous method. With VIII hours 20m. now obtained we refer to our star maps. From Plate I of the star maps of this Society, we find the following to be on the meridian. The Great Bear is just coming on the meridian, the star o which is represented to be on the snout of the Great Bear is on the meridian.

Next below the Great Bear we find the middle of Lyun, though α and Fl. 38 Lyucis, the only stars of the constellation which deserve any notice, are on the east side of the meridian about an hour distant.

Then from plate IV of the star maps we see on the meridian the western part of Cancer, β Cancri, is only a few minutes on the west, and it will take about 12 minutes for Præsepe or the beehive of Cancer to be on the meridian. Further down we find the western parts of Monoceros and Argo to be on the meridian. On the eastern side of the meridian and within 3h. 20s. we find a very large number of conspicuous stars. These are Capella of Auriga, Castor and Pollux of Gemini, Procyon of Canis Minor, all the bright stars of Orion, Sirius of Canis Major, and Canopus of Argo.

Table for finding the constellations on the Meridian at any hour of the night on any day.

		7 P.M.	8 P.M.	9 P.M.	10 P.M.	11 P.M.	Mid-night.	1 A.M.	2 A.M.	3 A.M.	4 A.M.	5 A.M.
January	6th	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	21st	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
February	6th	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
	21st	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
March	8th	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
	23rd	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
April	8th	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
	23rd	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
May	8th	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
	23rd	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
June	7th	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII
	23rd	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
July	8th	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
	23rd	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	I
August	7th	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	I	II
	23rd	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	I	II	III
September	7th	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV	I	II	III	IV
	22nd	XIX	XX	XXI	XXII	XXIII	XXIV	I	II	III	IV	V
October	7th	XX	XXI	XXII	XXIII	XXIV	I	II	III	IV	V	VI
	22nd	XXI	XXII	XXIII	XXIV	I	II	III	IV	V	VI	VII
November	7th	XXII	XXIII	XXIV	I	II	III	IV	V	VI	VII	VIII
	22nd	XXIII	XXIV	I	II	III	IV	V	VI	VII	VIII	IX
December	7th	XXIV	I	II	III	IV	V	VI	VII	VIII	IX	X
	22nd	I	II	III	IV	V	VI	VII	VIII	IX	X	XI

Paper on the Testing of Parabolic Mirrors.

By Dr. E. P. Harrison.

Messrs. S. K. Dhar & Bros., of Hughli, who manufacture mirrors for reflecting telescopes, have lent me the mirror which is exhibited this evening. It was tested by Babu Nagendra Nath Chatterji and myself in the Physical Laboratory at Presidency College, and the tests indicate that the figure of the mirror is excellent. The work of grinding and polishing seems to be very creditable to a local manufacturer.

It occurred to me that a short account of a method of testing telescope mirrors might be of interest to members who possess reflecting instruments, or who contemplate grinding their own mirrors. There are methods of testing which involve the calculation of what is called the aberration of the mirror, but for reasons of simplicity it is proposed to describe a more empirical process known as the "Shadow method."

The primary object and the chief difficulty in grinding and finishing a mirror for a reflecting telescope is to get a *spherical* figure. The sphere can afterwards be converted into the required paraboloid with comparative ease, but a sphere is the most satisfactory figure to start with.

The elementary theory of the shadow method of testing is, somewhat roughly, as follows :—

Several kinds of conicoid surfaces may result from the grinding of a glass or metal mirror :

(*i*) Prolate spheroids, which will be ellipsoidal surfaces of revolution, the major axis forming the principal axis of the mirror.

(*ii*) Spherical surfaces.

(*iii*) Oblate spheroids, which will be ellipsoidal surfaces, in which the minor axis of the ellipse becomes the principal axis of the mirror.

(*iv*) Paraboloids.

(*v*) Hyperboloids.

The diagram, Fig. 1, shows sections of a series of such surfaces, approximately drawn to indicate the general relation of one with another.

Suppose a mirror of true spherical form is placed so as to reflect light from a *small* aperture situated at its centre of curvature, the reflected beam will, as the

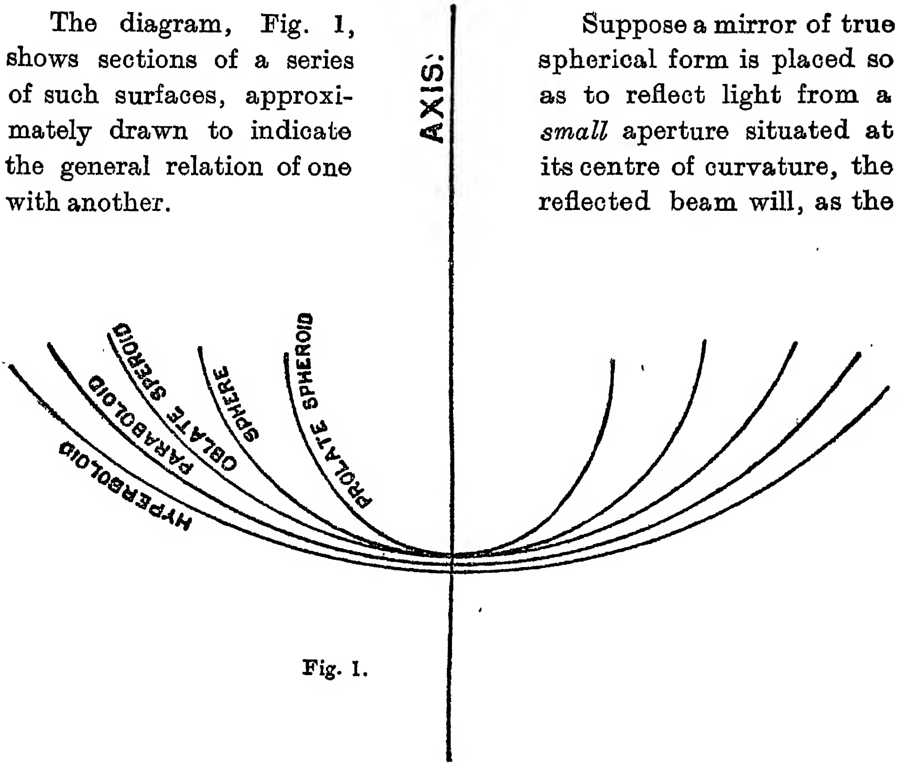
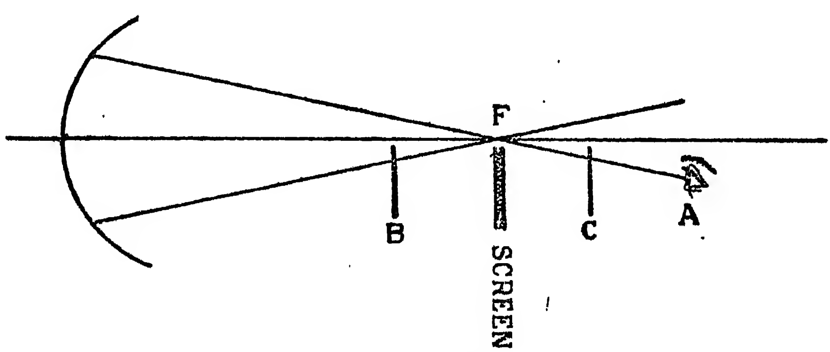


Fig. 1.

properties of a spherical mirror indicate, "come to a focus" *at* that centre of curvature. Source and image will coincide.

Consider this focus. (Fig. 2.)



PLAN
Fig. 2.

If the eye is placed at A, and a screen put in *at the focus F*, the light will very suddenly be cut off and the mirror suddenly appear dark or uniformly illuminated.

Should the screen be introduced at B, the appearance of the mirror would be as in Fig. 3 (a), the shadow moving bodily over the mirror.

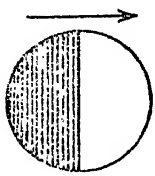


Fig. 3. (b).

Only when the screen is put in at the precise focus will there be *sudden* appearance or disappearance of illumination over the whole surface. By such means the focus can be located.

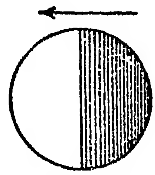


Fig. 3 (a).

Now consider a mirror whose figure is that of an oblate spheroid or flattened sphere. (Fig. 4.)

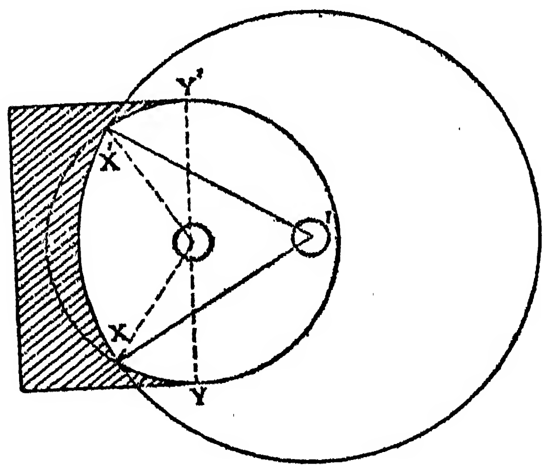


Fig. 4.

Its circumference may be considered as (i) part of a sphere of radius OX and centre O, and (ii) part of a sphere of radius O′X and centre O′.

This last forms the central portion of the mirror, while the sides X′ Y′ and XY are formed by the smaller sphere. The rays from the central portion of the mirror will come to a focus further from the mirror than those from the outside zones. Thus there will be no true centre of

curvature as in the case of a sphere, but only a *mean centre* which will be between O and O′.

The appearance of the mirror, when illuminated by an artificial star placed at the mean centre of curvature, and looked at through an eye-piece placed also in that position, but somewhat eccentrically (and with part of the reflected rays cut off by a screen), would be no longer uniform. It would consist of a gradation of shadows and high lights at different parts of its surface; these shadows would, however, *suddenly* appear as the screen was introduced at the mean centre of curvature, and as suddenly disappear on removal of the screen.

There would be hills at the sides, hollows at X and X′ and a hill at the centre. The eccentric method of illumination would show up the high lights on the tops of the hills and emphasise the shadows in the hollows, so that we should expect the mirror to have the appearance of Fig. 5 when looked at in the way described.

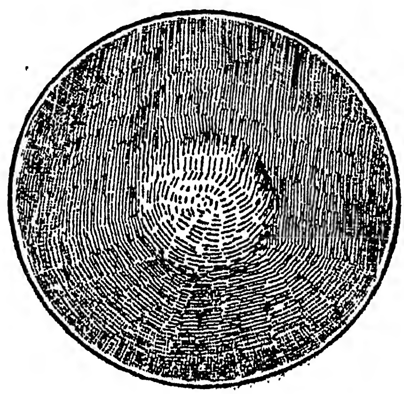


Fig. 5.

A section of the mirror-form could obviously be obtained from this shadow-diagram, and would be somewhat as shown in Fig. 6.

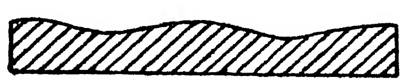


Fig. 6.

Accordingly, to make such a mirror spherical, we should have to grind away the hill in the centre and also the hills at the periphery. The resulting shadow-diagram would then be quite uniform, provided the true spherical figure had been obtained.

Next consider a mirror of hyperbolic type. This will differ from the oblate spheroid just discussed, in having a *depressed* central portion. The side portions (Fig. 7) have their focus further away from the mirror than the central portions.

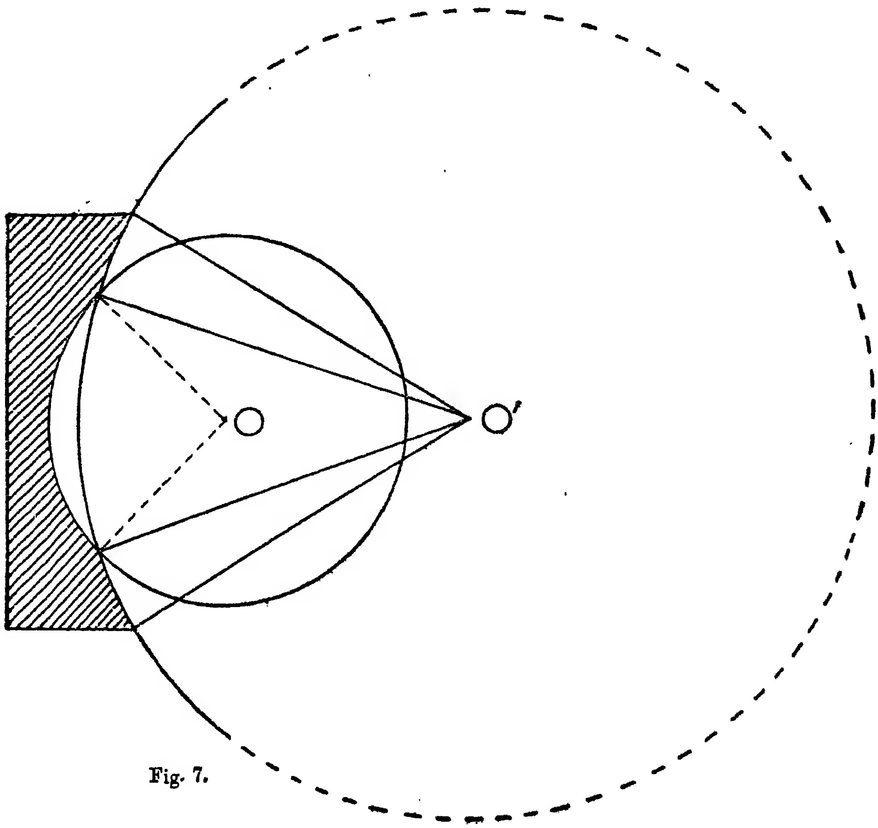
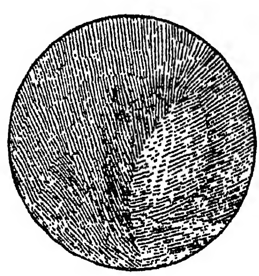


Fig. 7.

Fig. 8.



The figure, though much exaggerated, shows the hills in a zone near the circumference and a hollow near the centre. The shadow-diagram or appearance of the mirror, when illuminated by an artificial star and viewed from the centre of curvature, would then be as shown in Fig. 8, and the corresponding section of the mirror could be prepared and would be somewhat as shown in Fig. 9.

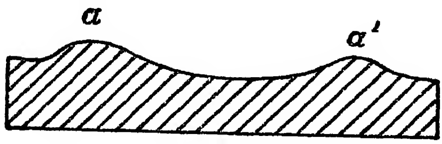


Fig. 9.

To make a hyperbolic mirror spherical, therefore, we should have to grind away the hills *a a'* (Fig. 9).

We are now in a position to perform an actual test on a mirror of unknown figure.

A bright source of light, such as a pin-hole in a metal lamp chimney, to serve as an artificial star, is placed at the mean centre of curvature of the mirror and rather eccentrically (*i.e.*, "off" the principal axis of the mirror). An eye-piece is placed with its focal plane at the same distance from the mirror as the artificial star. An opaque screen, gradually passed across the field of the eye-piece from left to right serves to locate the mean centre of curvature in the way described above.

If after these adjustments have been made the appearance of the mirror is like Fig. 5, an oblate spheroid is indicated, whose figure is flatter than the sphere and less flat than the paraboloid. If the appearance is like Fig. 9, an over-corrected or hyperboloid figure is indicated.

The actual section of the mirror can be deduced from the shadow-diagram in either case, and the mirror treated accordingly. The parabolic figure will be somewhere between the spheroid and hyperbola. It will show all the characteristics of a hyperbolic figure *but very faintly*, and has very suitably been described as a "study in greys."

A Query.

By R. Madhava Rau.

On the 25th of March (night), when I was standing in the verandah of my house talking to my brother, I noticed a very

bright object moving rather slowly from an easterly to a westerly direction. I came to recognise it to be a meteor, and it continued to be visible for seven to eight seconds more. The colour was bright green, and as Canopus was shining in the front, I compared the brightness of the meteor with that of Canopus and found it to be more than double. It left no tail, and in the end two pieces of red-hot matter like glowing pieces of charcoal fell down. The meteor was exceptionally bright and large. Its apparent course when produced just touched the edge of the Milky Way. Usually such meteors leave a hazy tail behind, but this was an exceptional case. Moreover, the meteor was of a very bright green colour, indicating the presence of barium. Can any of the readers of the JOURNAL let me know why it left no tail behind, what meteor shower was in progress, and whether meteors contain such elements of the alkaline earths as barium? The time when the meteor was seen was 8 hours 6 minutes (p m.)

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the month of May 1911.

Sidereal time at 8 p.m.

	H.	M.	S.
May 1st	10	33	36
,, *8th*	11	1	12
,, *15th*	11	28	48
,, *22nd*	11	55	24
,, *29th*	12	23	59

From this table the constellations visible during the evenings of May can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

			H.	M.
May	*5th*	First Quarter .	6	44 p.m.
,,	*13th*	Full Moon . .	11	40 a.m.
,,	*21st*	Last Quarter .	2	53 p.m.
,,	*28th*	New Moon . .	11	54 a.m.

Meteors.

Date.	Radiant. R. A.	Dec.	Character.
May 1-6th	338°	− 2°	Swift; streaks.
11-28th	331°	+27°	Slow; small.
May—June	235°	+ 9	Rather slow.
May—June	280°	+32	Swift.
May—July	252°	−21	Slow; trains.

Planets.

Venus—Is an evening star. It sets 3h. 1m. after sunset.

Saturn—The position of this planet on the 15th May at 8 p.m. will be R.A. 2h. 39m. 17s. Dec. 13° 16′ 14″ N. The time of its rising will be 4h. 20m. a.m. on the 16th May.

Mars—The position of the planet on the 15th May at 8 p.m. will be R.A., 23h. 13m. 12s. Dec. 6° 55′ 26″ S. The time of its rising will be 1h. 29m. a.m. on the 16th May.

Jupiter—The position of the planet on the 15th May at 8 p.m. will be R. A. 14h. 23m. 54s. Dec. 12° 51′ 15″ S. The time of its setting will be 4h. 10m. a.m. on the 16th May.

Eclipse of the Moon.

There will be a penumbral eclipse of the moon on the 12th May 1911.

	D.	H.	M.
First contact with penumbra	12	21	15
Mid Eclipse	12	23	36
Last contact with penumbra	13	1	37

Extracts from Publications.

Speaking at the meeting of the British Astronomical Association in February last, Dr. Crommelin pointed out an easy method of predicting the approximate time of an approaching perihelion passage of Encke's Comet without complicated calculation. The planet which particularly disturbed the motion of Encke's Comet was Jupiter, whose influence might make a difference of two or three weeks in the time of revolution. The other planets could affect it only by a few hours. Now, 18 revolutions of the comet

did not differ much from five of Jupiter, and consequently the Jupiter perturbations nearly repeated themselves after that period. They had now observed Encke's Comet for more than two of these periods of 59 years, and by tabulating the interval in days between each perihelion and the one 59 years later, they could plot the result as a curve. If the plotting was carefully done, and the curve carried on by estimation, they could predict a return within a day or so with a minimum of labour. The interval between the perihelion of 1786 and that of 1845 was 21739·7 days, but between those of 1848 and 1908 it was only 21705·0. The diminution was due to the acceleration in the comet's motion.

The resulting curve was sinuous, and now showed a tendency to turn up again, but he did not expect that the upward movement would be maintained for long. As the comet is due this year, Dr. Commelin estimated from the curve its date of perihelion passage to be August 20th, and he thought it would be right within a day or two.

[*Journal of the British Astronomical Association.*

Much attention was given to Halley's Comet, which was first seen in 1909, November 18th, as an extremely faint object with the equitorial telescope. On November 30th it was a little south of Aldebaran and quite within the glare of that bright star. During December 1909, and January and February 1910, the increase of brightness was very slow, and at the beginning of March the comet was lost on the sunset horizon. It was next seen with a bright nucleus on the morning of April 21st. The retrograde movement continued till April 25th, when it turned a short curve and started on a direct course. On May 2nd it was a splendid telescopic object with a fine tail, down the centre of which was a distinct dark-channel. The nucleus was distinctly circular, and the comet was well visible to the naked eye passing a little north of 31 Piscium. After May 14th the comet came too near the sun for further morning observations, but was just caught with the naked eye on the evening of May 23rd, and was well seen the next night. The finest view was on May 25th, when the tail, though faint, could be traced 10° or 12°. On June 3rd the comet was passing near α Sextantis, and it was last seen much fainter and near the horizon on June 14th, after having been observed for nearly seven months, or more exactly 204 days.

[*Journal of the British Astronomical Association.*

Halley's Comet continues to be observed with powerful instruments. Prof. Barnard is following it assiduously, and has forwarded the following observations:—

G. M. T.					App. R. A.			App. S. Dec.		
	D.	H.	M.	S.	H.	M.	S.	°	′	″
1911 Jan.	22	20	23	59	11	33	24·51	18	20	14·3
,,	22	21	7	5	11	33	22·42	18	20	11·9

We also hear that it was observed at the Cape with a 12-inch refractor on February 5th. It seems likely that it will be followed at least till its next conjunction with the Sun, which will occur about August. Needless to say, it has already beaten its former records for length of period of observation, both before and after perihelion.

[*Journal of the British Astronomical Association.*

The following observations of Nova Lacertæ have been communicated to the British Astronomical Association by Revd. T. E. R. Phillips, M.A., F.R.A.S.:—

Date.	Magnitude of Nova.		Remarks.
	By direct comparison with 12¼inch speculum.	By use of Diaphragm on 2·9 in O. G.	
January 6	7·6	...	Decidedly red. Spectrum shows two bright lines approximately near middle separated by conspicuous dark space. Other bright lines suspected.
,, 7	7·6	...	......
,, 15	7·6	...	Still very red. Estimate of magnitude probably too high.
,, 24	8·1	...	Less red. Additional bright lines glimpsed one towards the violet and another at a greater distance towards the red.
,, 28	8·4	8·6	Redder again.
,, 30	8·4	8·7	Very red. Dark space in spectrum has disappeared; two very bright lines close together in yellow or orange.
,, 31	8·4	8·6	......

Date.	Magnitude of Nova. By direct comparison with 12¼inch speculum.	Magnitude of Nova. By use of Diaphragm on 2·9 in O. G.	Remarks.
February 1	8·6	8·8	......
„ 7	8·6	...	Stars very dim through thin cloud.
„ 15	8·7	...	Stars dim through their cinus.
„ 19	8·8	9·1	Sky very transparent. Nova orange yellow, certainly less red. Spectrum now cut off sharply at red end beyond brilliant line with another less bright line close to it on the more refrangible side. (Perhaps the two lines mentioned under January 30). Then a comparatively **dark** space with indications of other bright lines further towards the violet.

Summary:—

(1) The decline of the Nova, if not quite regular, has been without any of the sharp and rapid fluctuations such as distinguished Nova Persei in 1901.

(2) There have been changes in the depth of colour.

(3) There have been changes in the spectrum.

(4) For some reason the brightness of the Nova appears about a quarter of a magnitude greater in the large reflector than when using a diaphragm on the small refractor. Probably the reason suggested above is the true one, but it is possible that my eye is more sensitive to red than white light in a degree depending on the apparent brightness of the object.

[*Journal of the British Astronomical Association*.

Looking at the sky on a clear night, we see from two to three thousand stars. In trying to tell you something about these three thousand stars, I will endeavour to explain their distance and how it is measured and something about them. Assuming that the Sun is about 93,000,000 miles distant from the earth, and that the earth travels round the Sun in a year, in six months it will be on the other side of the Sun 180,000,000 of miles from its starting point, and we can take that distance as our base line for measuring the distance of the stars. Even with such a base line their

distance has proved so enormous that it has not been possible to measure the distance in the roughest possible manner of more than eighty or one hundred stars. Two methods have been adopted—one of measuring the angle directly from each end of the base-line, called the direct method. I think in no case has the angle exceeded half a second, or a space so small as to be almost impossible to get accurately. The other method, called the relative method, consists of selecting two stars close together, and seeing whether every six months there is any difference in the distance between them, as if there is one much further distant than the other, one would be almost stationary, while the closer one would show motion, the amount of that motion enabling its distance to be calculated. So far as known, Alpha Centami is nearest to earth, distant about 25 billions of miles, and light travelling 180,000 miles a second takes more than four years to traverse the distance. Alpha Centami, although to the naked eye a single star, is really the finest double star in the heavens. The two stars of which it consists revolve round their common centre of gravity in a period of 81 years. Knowing their distance from the Sun, their distance apart from one another, and the time in which they make a complete revolution of their complete year, astronomers are enabled to calculate their weight. And the remarkable fact is found that their combined weight is about equal to twice that of our Sun.

[*English Mechanic*.

Let us take a bundle of rays from the Sun and examine them. We will find it to be a most beautiful and wonderful collection, permitting of being arranged like organ-pipes for the hundreds of different kinds of wave lengths, each having its own peculiar property as we interpret it. We recognise and treat generally three large divisions: those rays that give us essentially heat, those that produce the sensation of light, and those that manifest themselves most by their chemical action as shown by the photographic plate. At the moment, we are most interested in those that give us heat. Next let us try and find out what measure of heat the Sun is sending to us. Immediately two considerations present themselves—that of absorption and that of radiation—that is our receiving device must be such that we catch and retain all the heat rays that fall upon it. For this purpose we use therefore a black surface of given dimensions and expose it at right angles or normal to the rays of the Sun to measure how much heat is absorbed. But here a factor comes into play that must not be overlooked. Those rays from

the Sun before reaching us pass through our atmosphere, a factor in the life upon our earth that cannot be overestimated. The heat of the surface of the earth is a matter of absorption and radiation. Of the former, fully three-fourths is obtained from the wave lengths that lie between the violet (·4 μ) and ultra red (1·1 μ) of the solar spectrum, while the radiation is by comparatively long wave lengths, the maximum intensity being in the neighbourhood (2 μ). Although of a hot and cold body, we readily say that, relative to each other, the hot body radiates and the cold body absorbs heat; but the ultimate mechanism between absorption and radiation is not known. It is obvious that the solar rays in passing through our atmosphere must suffer some absorption, and selective absorption at that, dependent upon the thickness of the layer, upon its temperature, density and gaseous constitution. The last is the point to which we shall give a little consideration in order to offer a plausible explanation at least of the varying thermal conditions which we know have obtained on the surface of the earth in order to produce these geological epochs as shown by a tropical fauna and flora in higher latitudes, as also by glacial deposits.

At present the composition of the atmosphere is made up mainly of nitrogen and oxygen, there being in volume nearly four times as much of the former as of the latter.

There are traces of other gases besides. Carbonic acid gas or carbon dioxide, which plays so important a part in the earth's history, is represented by about ·03 volume per cent. It must appear obvious that, with the continual changes going on on the earth, the weathering and disintegration of rocks, the deposition of calcareous and other matter at the bottom of the ocean to form new geological beds, the continual cycle of life and death in the animal and vegetable kingdoms, all drawing on the vast reservoir of the atmosphere, there must occur some changes in the relative constitution of our atmosphere, and these latter would necessarily, by selective absorption, modify to some degree the heat of the surface of the earth. From investigation, it appears that a slight change in the quantity of carbonic acid gas in the atmosphere would materially affect the climate: an increase would raise the temperature and a decrease lower it. For instance, it has been computed that an increase from ·03 to ·09 per cent. would raise the temperature from 12° to 16° F. Such a general rise would have far-reaching results—results that would be of a magnitude quite competent to account for the phenomena we are trying to explain. But the question arises, even if we grant the effect of an increase of carbon dioxide, how could an increase of this gas be produced?

Now, it is well known that the active volcanoes emit vast quantities of aqueous vapour and carbonic acid gas. Here, then, we have a factor that may give us the desired data, provided evidence can be adduced that there has been sufficient variability in volcanic activity. When we look over the various geological epochs of the earth's history and their accompanying formations, which are to a great extent a matter of chemical combinations, and the latter are largely dependent upon temperature, it is found that volcanic activity has been variable. From this, then, we seem to be justified in believing that the surface heat of the earth has suffered changes through the varying quantity of carbon dioxide present in the atmosphere, and a change sufficient to produce those long period climatic changes that certainly have existed on our earth, and which have left such indelible evidences of their presence at one time. Granting the modifying heat effects of carbonic acid gas, we may take into consideration the work of man. I allude to the consumption of coal. Two processes take place for combustion—oxygen is withdrawn from the atmosphere, and carbon dioxide is added, the latter stimulating plant assimilation besides raising the general temperature, as we have seen above, and the former assisting in the restoration of the equilibrium of the oxygen in the atmosphere, as we know that plants in general exhale oxygen. To that the depletion of our coal beds is not an unmixed evil, and it might be added that the smouldering of our coal deposits, which have been going on for a long time in the Mackenzie basin, may mitigate the climate there to an appreciable degree. These deductions are qualitatively sound, and they may be so quantitatively.

Before leaving this subject of Solar radiation and absorption, it may be stated that the most recent researches on this subject give, for what is known as the Solar constant, about 2 calories, *i.e.*, the direct rays of the sun after allowing for atmospheric selective absorption, would heat a gramme of water 2° C in one minute.

[*English Mechanic.*

Notices of the Society.

Election of Members.

The attention of members is invited to Bye-law No. 14, regulating the election of persons who desire to join the Society. It is hoped that those who are already members

will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherjee.

The Library.

An opportunity will occur during the next few months, owing to one of the members of the Society going to England, of obtaining books cheaply there for the library. A subscription list has already been opened, and several members in Calcutta have subscribed and enabled the Council to make a beginning with the Library. Other members outside Calcutta, however, have not yet come forward, and as the Library will be one of the most important adjuncts of the Society, and will be available to members both in and out of Calcutta, those who have not done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

A number of books have already been received and can be borrowed by members in accordance with the Bye-laws in the last number of the JOURNAL.

The books available can be ascertained from the Assistant Librarian and a catalogue will issue shortly. The reading room of the Society in the Imperial Secretariat is now opened for the use of members daily from 5 to 7 p.m. except on Wednesdays and holidays, and from 3 to 5 p.m. on Saturdays, unless that day is a holiday.

Subscriptions.

Some of the subscriptions are still due for the current session from members. Those who have not yet done so are requested to remit the amounts to the Treasurer.

The Treasurer will also be glad to receive those donations promised for the Library and quarters which have not already been paid, as the Council wish to take full advantage of the promised assistance as soon as possible during the present session.

Classes for Beginners.

The Council have arranged to hold a series of four classes for beginners in Calcutta, to enable those who wish to learn the rudiments of the science and how to use their Star Charts to do so. Mr. B. M. Rakshit, late of the Alipore Observatory, has kindly consented to hold the classes, and the names of those who wish to take advantage of the classes should be sent to him at 77-3, Musjid Barry Street, Calcutta, or to the Secretary, Mr. P. N. Mukherjee, without delay.

Meetings.

The ordinary meetings of the Society will be held on the following dates :—

1911.

May 30th	June 27th

The meetings will commence at 5 p.m. and, until further notice, will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . . H. G. Tomkins, F.R.A.S., 9, Riverside, Barrackpore.

(2) *Secretary (Scientific)* . W. G. Burn, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.

(3) *Do. (Business)* . P. N. Mukherji, M.A., F.S.S Imperial Secretariat Buildings, Calcutta.

(4) *Treasurer* . . . U. L. Banerjee, Office of the Acctt. General, Koila Ghat Street, Calcutta.

(5) *Librarian* . . . Ashutosh Mittra, M.A., 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.

(6) *Editor* . . . Chas T. Letton, 8, Hastings Street, Calcutta.

(7) *Directors*:—

General Section . . Dr. E. P. Harrison, Presidency College, Calcutta.

Lunar Section . . H. G. Tomkins, F.R.A.S., 9, Riverside, Barrackpore.

Meteor Section . . B. M. Rakshit, B.A., 77-3, Musjid Barry Street, Calcutta.

Variable Star Section . Lt.-Col. Lenox Conyngham, R.E., F.R.A.S., Dehra Dun.

Photography . . R. J. Watson, 37, Park Road, Barrackpore.

Instruments . . . S. Woodhouse, 15, Wood Street, Calcutta.

Photo. Engraved & printed at the Offices of the Survey of India, Calcutta, 1911.

Photograph of the trail of the Meteorite of the 24th of November 1910, taken at Mhow by Sergeant Hampstead and reproduced in the journal through the courtesy of the "Times of India."

The Journal
of the
Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 7.

Report of Meeting of the Society held on Tuesday, the 25th April 1911.

H. G. TOMKINS, F.R.A.S., *President*, in the Chair.

The usual Monthly Meeting of the Astronomical Society of India was held in the Imperial Secretariat Buildings (ground floor) on Tuesday, the 25th April 1911.

The Proceedings were opened by the President, who called on Mr. U. L. Banerjee, in place of the Secretary who was ill, to read the Minutes of the last meeting, which were duly confirmed. The President next read letters from the Astronomer Royal, Greenwich, and Professor Turner of Oxford, congratulating the Society on the start it had made, and agreeing to place the Society on their lists of exchanges. The letters were received with applause, and a vote of thanks was passed to the Astronomer Royal and Professor Turner, the special thanks of the Society being conveyed to the former for his promise to send the Society lantern slides occasionally for their meetings of objects taken at Greenwich. It was also announced that the Society had received a very valuable present from Lt.-Col. Lenox Conyngham in the Atlas Stellarum Variabilium. The work was in several parts, and would be one of the most valuable contributions to the Library. The gift of the Atlas, which was on view, was greatly appreciated by members, and a hearty vote of thanks was accorded to the donor for his generosity and interest in the Society.

Other presents announced were :—

(1) The Monthly Weather Review for December 1910 from the Director-General of Observatories in India.

(2) Annuaire Astronomique for 1912.
Annales de l'Observatorise Royal de Belgique received from the Royal Observatory, Belgium.
(3) Bulletins of the Barcelona Astronomical Society for January, February and March 1911.
(4) Royal Astronomical Society's Monthly Notices for February 1911.
(5) Journal and Transactions of the Leeds Astronomical Society for 1909.
(6) Bulletins of the Italian Astronomical Society of Turin for January and February 1911.

The election of the following members by the Council was then confirmed :—

1. Mr. B. R. Mukherji
2. Mr. Kilian Euler.
3. Mr. Joseph Connel Ritter.
4. Mr. Frederick Beale.
5. Mrs. L. Lukis.
6. Mrs. E. V. Keelan.

The President then read extracts from a paper by Professor Emanuelli of Rome on the Total Eclipse of the Sun of April 1911, which had been very kindly translated and submitted by Mrs. Fairweather of Barrackpore, who, though not a member of the Society, was interested in its work. The extracts created considerable interest, and were to be placed in the Library with the original paper. A vote of thanks was accorded to Mrs. Fairweather for the work she had done for the Society.

The next paper of the evening on Time, and How It is Measured, was read by Mr. Rakshit, Director of the Meteor Section, who dealt with his subject in a very interesting and exhaustive manner, ably illustrating his remarks with lantern slide pictures.

In calling for a vote of thanks to Mr. Rakshit, the President remarked that he (Mr. Rakshit) took a great interest in the Journal and had now contributed several papers on different subjects towards it, all of which he had dealt with in a very able manner, and members would, he thought, look forward to seeing the present paper in print. A hearty vote of thanks was duly accorded to Mr. Rakshit.

A lantern slide was then shown of the Meteor of 24th November 1910, which had been taken by Sergt. A. Hempstead, Mhow, the negative of which Mr. H. B. Holmes had been fortunate enough to obtain the loan of, and had kindly sent it in to the Society for reproduction in the Journal as well as for the Monthly Meeting. This slide proved of great interest to all present, as the subject had already afforded

considerable discussion and comment at the last Monthly Meeting.

Mr. Holmes—You will remember that when I read my paper at the last Meeting, I gave you a very rough drawing of the course of this Meteor as it seemed to appear and was photographed by Sergt. Hempstead. I have now been fortunate enough to obtain the loan of the original negative from Sergt. Hempstead, and this reproduction will give you a clear idea of the original, which bears out what I said at the last meeting, that instead of starting right away from the top of the picture, it seems to start part of the way down. The zig-zag course of the Meteor, these bright spots, and its seemingly sudden end here, are the points which I wanted to draw attention to.

The President—We are very fortunate indeed in having obtained this slide. Mr. Holmes telegraphed down to Sergt. Hempstead and asked him if he could not see his way to oblige the Society by lending his negative for a reproduction, and Sergt. Hempstead has very kindly sent it to us. We have been enabled to make this reproduction which we have before us of the luminous trail of the Meteor, and I think that the photograph is probably unique and at any rate very rare.

The President then read a letter which he had received from Mrs. Voigt on the subject of meteors.

Mr. Holmes—What is her point ?

The President—I think the idea is that a meteor may have some kind of rotation on its axis, and that on combustion taking place, this might result in a sort of spiral trail, giving the effect of the bright spots in it which appear in this photograph. The idea is ingenious, and I am sorry Mrs. Voigt could not be here to join us in this discussion.

Another meteorite has lately been seen in India, and I think one of our members has something to say on the subject.

Mr. Bhima Sena Rau then read an account from the *Bangalore Post* of a Meteor seen on the 19th of April 1911 at Bangalore, and another account of the same Meteor which appeared in the *Madras Mail.*

The President—There is one other point, which is, that there has just appeared in the Scientific Journals a contention that the luminosity of meteors may after all not be due to the accepted idea of friction with the earth's atmosphere. This comes as rather a shock to some of us, who may have taken it for granted that the luminosity is caused by the earth's atmosphere without considering the matter very deeply. The author of the suggestion works out the amount

of air which a meteor from space would encounter on reaching the earth's atmosphere, and compares it with the air resistance which a bullet from a rifle encounters at sea level. The result in his opinion is to show that the resistance would not be sufficient either to stop the meteor or to render it luminous. The matter is one which evidently needs further investigation, and perhaps some of our members might take it up.

Mr. Holmes—Before we close this subject, I should like to say one thing in regard to Sergt. Hempstead. As I mentioned to you the other day, I think Sergt. Hempstead has taken so much interest in us, and been so obliging, that I should like to forward him free copies of the JOURNALS in which anything on the subject of this meteor appears.

The President—I think that goes without saying.

A hearty vote of thanks was duly returned to Mr. Holmes for his very interesting subject, and the amount of trouble and pains he had been at to obtain the negative, and to Sergt. Hempstead for lending the negative.

The President then showed a lantern slide diagram sent in by Mr. Hart of Mangalore, also reading a note on its use to determine the position of Mercury and Venus sent in by the same gentleman.

Mr. Simmons—What would be the present position of Venus to-day, being the 25th of April 1911 ?

The President—It would be just about here (indicating the place on the diagram).

A vote of thanks was duly accorded to Mr. Hart.

The Chair now being taken by Mr. Simmons, the President read a short paper submitted by himself on Mars, illustrating the same with some very beautiful lantern slide pictures received from Dr. Lowell.

Mr. Holmes—Do you mind putting on the other slide again. There is a great difference between the two slides.

The President—They were taken in two different years.

Mr. Holmes—How does he account for the fact that on one there is a mark practically right across the Equator; then you have the Polar Cap ; then below that it is more or less fairly clear ; with the other slide it seemed to me to be just the reverse.

The President—I think that does bring us to his point. The Polar Cap is much larger on one set of photographs than on the other. Dr. Lowell's contention is that when the snows melt and the Cap diminishes, the water is taken by some means towards the Equator, where it causes vegetation to spring up. I take it therefore that in the two slides there has been a difference of the seasons, thus giving rise to the contrast between the photographs.

Mr. Holmes—Does the same thing apply to the Southern Hemisphere ?

The President—Yes ; I think so. Of course we are not in a position to see that in these photographs.

Mr. Simmons—In inviting discussion on the subject of the President's paper, Mr. Simmons said one point would be the "Canals." The President had rightly directed attention to the rather unfortunate selection of the term. It suggested human agency and was an instance of the great influence words exercised on thought. If the word "Channel" had been used instead of "Canal," much of the discussion which has taken place over the subject would probably have been avoided. Then, with regard to the phenomenon of "doubling," he thought it was noteworthy that while the earliest observer had counted 177 canals, Professor Lowell had counted 437. The phenomenon probably was an optical illusion as suggested by some but, on the other hand, the increase in the number observed was due to the use of instruments which could not be assumed to have deteriorated in the interval. Photographs also reproduced the canals. Then, again, in dealing with the question of life, the anthropomorphic tendency of the human mind had to be kept in view. The life in Mars need not be a mere duplicate of the life forms with which we are familiar. The geological eras of our own earth's history gave us instances of forms unlike those now in existence ; and the microscope revealed a world of life forms in our midst which did not resemble those with which we are all familiar in the world around us. He declared the subject open for discussion.

Mr. Bhima Sena Rau—Has Professor Lowell mentioned the breadth of the canal on the figures ?

The President—Yes, about 2 miles. Of course it is an open question whether a line 2 miles will show on these small pictures.

Mr. Holmes—Do the canals extend right up to the Polar Cap ?

The President—Yes.

Mr. Dutt—Mr. President, may I enquire if a 3″ refractor will show the Polar Caps ?

The President—Yes, certainly it would show the Polar Caps. I do not think it would show the canals, however.

Mr. Dutt—What is about the size of a telescope which would show the canals ?

The President—I have seen some accounts by an observer with a telescope 4½″ diameter, who thinks he has seen them. Personally, I rather doubt it, and should not think anything

less than 8 or 10 inches would show them; but though I have no doubt they are there, I do not mind saying that I have never seen them, not having made any great study of Mars.

A vote of thanks was duly returned to the President for his paper, and also a vote of thanks was accorded to Dr. Lowell.

The President next showed two other slides received from Dr. Lowell, the first being a photographic picture of Jupiter.

Mr. Holmes—The belts are clear; what are they?

The President—Yes, those are the equatorial bands. They are generally considered to be atmospheric phenomena on Jupiter.

The next picture shown was a very beautiful photograph of Saturn.

Mr. Ramaswami now read a note on a diagram which he had drawn, illustrating the Lunar eclipse which was to take place on the 12th May 1911. He explained that was only a penumbral eclipse, but made the diagram in the hope that some of the members would look out for it.

With a vote of thanks to Mr. Ramaswami, the proceedings came to a close, and the President then adjourned the Meeting to Tuesday, the 30th May 1911, at 5 p.m.

A Note on the Penumbral Eclipse of the Moon, 12th May 1911.

By C. Ramaswami.

The diagram opposite, drawn roughly to scale, represents graphically the penumbral eclipse of the moon in May.

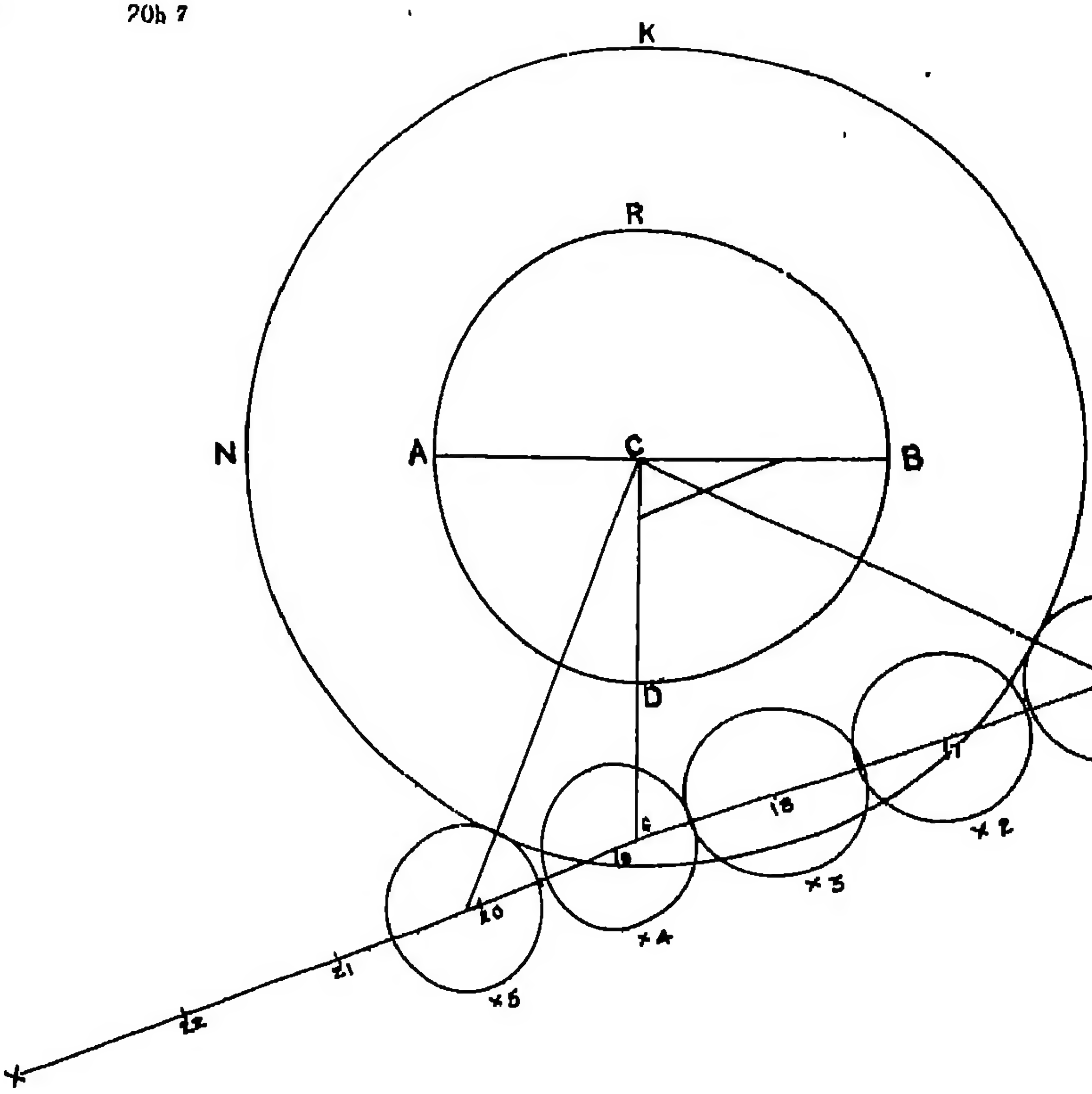
A. R. B. D. is the Earth's shadow and K. M. N. the penumbra. The straight line LX represents the path traversed by the centre of the Moon, and the small circles X_1, X_2, etc., show the positions of the Moon at different times. As the circles representing the Moon do not intersect the circle A. R. B. D. but only the outer circle K. M. N. the eclipse is only penumbral. The beginning and end of the eclipse are easily determined from the diagram. The Moon travels in the direction LX and the eclipse will begin when the Moon touches the penumbra, or in our diagram at the point where the little circle representing the Moon touches the K. M. N. Drawing this circle the time can be easily read off from the line LX, which is about 15h.-50m; or more accurately 15h.-46m. The end of the eclipse is similarly seen to be at 20h.-7m.

The time used throughout is Greenwich mean time, which can be converted into Calcutta Standard Time simply by the addition of 5½ hours.

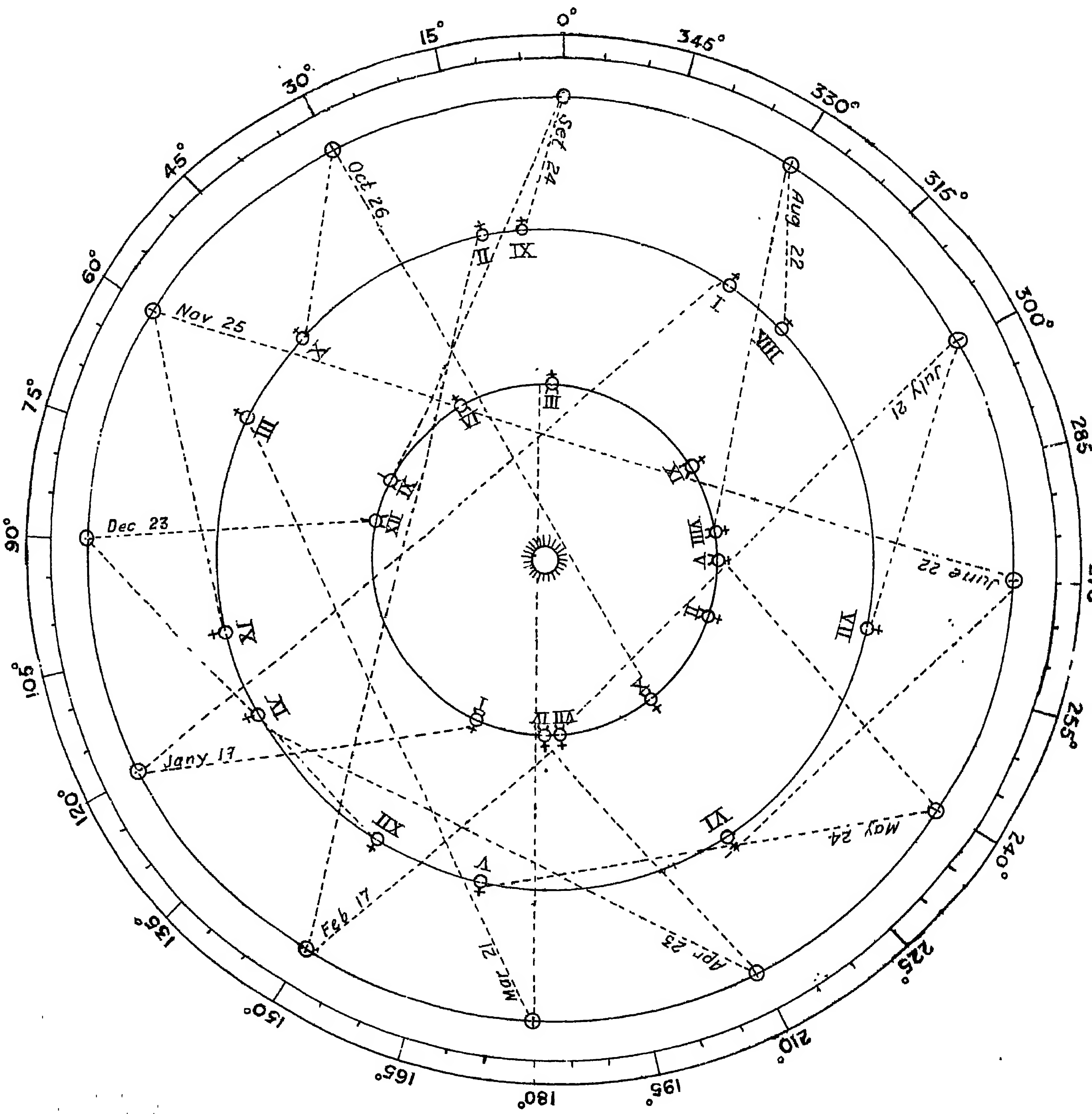
NWICH MEAN TIME

CONTACT WITH PENUMBRA } 15h 18'

CONTACT 20h 7



MOVEMENTS OF MERCURY & VENUS IN 1911.



The Movements of Mercury and Venus in 1911.

By H. Hart.

The accompanying diagram will show the movements of Mercury and Venus and their respective positions in regard to the Earth and Sun on the days on which the Sun enters the different signs of the zodiac. Their positions on intervening days can be easily calculated.

EPHEMERIS FOR 1911.

Jan. 5.—Mercury in conjunction with Venus.
Jan. 9.—Mercury in inf. con. with Sun.
Jan. 29.—Venus at greatest hol. lat. S.
Mar. 20.—Mercury in sup. con. with Sun.
May 21.—Venus at greatest hol. lat. N.
July 3.—Mercury in sup. con. with Sun.
July 7.—Venus at greatest elongation
Aug. 10.—Venus at greatest brilliancy as Evening Star.
Sep. 9.—Mercury in inf. con. with Sun.
Sep. 11.—Venus at greatest hol. lat. S.
Sep. 15.—Venus in inf. con. with Sun.
Oct. 22.—Venus at greatest brilliancy as Evening Star.
Oct. 23.—Mercury in sup. con. with Sun.
Nov. 25.—Venus at greatest elongation.
Dec. 25.—Mercury in inf. con. with Sun.

It will be observed that Mercury and Venus are evening stars while they are on the left hand of the Earth looking towards the Sun, and moving stars when on the right hand; and the diagram will show their angular positions in respect to the Sun.

Time and How it is Measured.

By B. M. Rakshit.

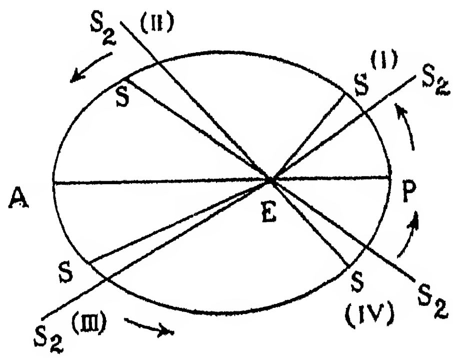
Time is measured by succession of events. If one thing occurs after another, we say the second event happened after the first, but in order to determine how long after the first the second happened we want an interval between two events which is always the same, *i.e.*, our unit of time and celestial phenomena afford us best units. The first and the most important celestial phenomenon which enables us to measure time is the rotation of the Earth on its axis or the apparent revolution of the sphere of the heavens. Hence,

if we take a point in the heavens which has either no proper motion or a motion which is practically uniform, *i.e.*, the change in the rate of motion of which in the course of many thousand years is insignificant, the two successive transits of such a point over the meridian of a place will afford us a very satisfactory means of measuring time. The first point of Aries or the intersection of the Equator with the ecliptic is a point in the heavens which has a motion of about 50·26″ of arc annually, but the change in this rate of motion does not amount to $\frac{1}{100}$th of a second in the course of two or three thousand years, for the annual change in the rate of motion is about (·0002) $\frac{1}{5000}$th part of a second of arc. The time taken by the two successive transits of this point, therefore, over the meridian of a place in consequence of the rotation of the earth on its axis is taken as one of the principal units of time. Such an interval is called a sidereal day which is defined to be the interval between the two successive returns of the Vernal equinox, or the first point of Aries, to the meridian of a place. Hence astronomers have a clock so adjusted that its hour hand makes one complete revolution in one sidereal day. On its dial are marked 24 hours and not 12 hours as in our ordinary clocks, and it shows 0h. 0m.-0s. at the instant when the first point of Aries is on the meridian of the place whose time it indicates. The time shown by such a clock is called sidereal or star time. As the first point of Aries is not a visible point in the heavens, we must have some means to examine the accuracy of our sidereal clock, *i.e.*, how much it is out of the true sidereal time of the place whose time it is intended to show. The method adopted to ascertain the clock error is to observe with a transit instrument the time when any of the clock stars or stars whose positions have been correctly ascertained crosses the meridian. Thus we see how the rotation of the Earth on its axis affords us means to measure time. But for all civil purposes such a method of measuring time is not useful, and the apparent motion of the sun in the heavens affords us useful unit of measuring time. The time obtained from the motion of the sun is called solar time. A solar day is defined to be the interval between two successive returns of the sun to the same meridian. The interval between two successive returns of the true sun to the same meridian is not always the same. The inequality is due to the fact that the sun's daily motion in R. A. is not uniform. It passes through 360° in 365d-5h.-48m.-47·8s., from which we find that the mean daily motion in R. A. is 59m.-8·3s. As a solar day or the two successive returns of the sun to the same meridian is equal to the time which the given meridian takes to pass through 360° and the angle

which the sun has moved in R. A. in the interval between its two successive returns to that meridian, solar days, *i.e.*, day and night taken together, are longer when the sun's motion in R. A. is greater, and shorter when it is less than the mean value. Although a solar, or speaking more definitely, an apparent solar day is not uniform in length and therefore not suited to be employed directly as a unit for measuring time, it marks the succession of light and darkness, and therefore must be accepted by man in his civil life to regulate his time. In order to obtain from it a proper unit to measure time, astronomers have made the following modification of it. Let us suppose another sun to move uniformly along the Equator with the mean angular velocity of the true sun, namely, 59m.-8·3s. per day, then the days marked by this imaginary sun are the same in length and equal to the mean of the lengths of the apparent solar days in a year. Hence a clock whose motion is uniform may be regulated to show the diurnal positions of the mean sun with reference to a meridian, *i.e.*, when the mean sun is on the meridian the clock indicates 12 o'clock noon, and when on the lower meridian 12 o'clock midnight, and any other position of the mean sun before or after the meridian is indicated by the number of hours before or after mid-day. But the mean sun is not a real thing and cannot be directly observed as our real sun. Hence we must know the mathematical relation between the real sun and the imaginary mean sun, which will enable us to determine the position of the mean sun by observing that of the real sun, *i.e.*, we must know the difference between the apparent and mean time at any instant. This interval is called equation of time and is usually considered positive when the mean noon precedes the apparent noon.

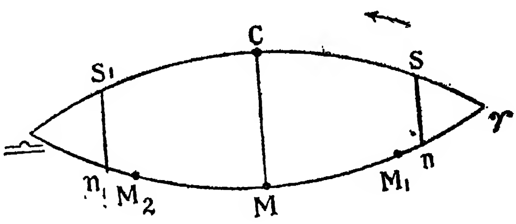
To find out the connection between the mean and the apparent sun astronomers imagine another body moving in the ecliptic with the true sun's mean motion. This imaginary body may be designated as the second imaginary sun. Hence we have three things—(1) the real sun which moves in the ecliptic with unequal motion and whose positions indicate apparent time; (2) first imaginary sun called the mean sun which is supposed to move along the Equator with the true sun's mean motion in R.A. and whose positions give us mean time or true clock time; and (3) the second imaginary sun moving along the ecliptic with the true sun's mean motion and is an auxiliary imaginary body to find out the relation between the real and the mean sun. The relation between the real and the second imaginary sun is found, and also that between the second imaginary sun and the mean

sun, and hence the connection between the real and the mean sun, *i.e.*, the connection between the apparent and mean time is determined. The first two laws of Kepler are (I) Planets describe ellipses round the sun having the sun in one of their foci. (II) The areas swept out by the radius vector are equal in equal times. It would be the same thing if instead of considering the sun fixed and the earth moving round it, we consider the earth fixed and the sun moving round the earth according to the laws mentioned before. First, we shall find out the relation between the true



sun moving along the ecliptic according to Kepler's second law, and the second imaginary sun also moving in the ecliptic but with the mean angular velocity of the true sun, namely, 59m.-8s. per day. Let E be the position of the earth and P that of the sun when it is nearest to the earth, and let the real sun S and the second imaginary sun S_2 start from P at the same time. Since in this part of the orbit the radius vector is less than its mean value, it will describe greater area in a unit of time than it would do where it has mean value. Hence the angular velocity of the true sun in this part of the orbit is greater than the mean value, and as the motion is from west to east, the true sun S is east of the second imaginary sun S_2. The latter therefore will be on the meridian earlier than the former, and the equation of time due to this cause is positive in this part of the orbit. At present the time of perigee or the position of the sun nearest to the earth is 3rd January and its daily angular velocity at that time is 61′-10″. The daily angular velocity of the true sun gradually diminishes as it passes from P towards A, which is the position when the sun is at the greatest distance from the Earth, *i.e.*, apogee, which at present takes place on 3rd July. In passing from P to A the real sun is ahead of the second imaginary sun as is shown in the positions I and II

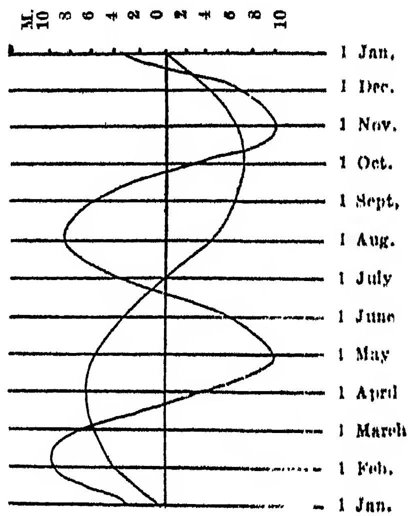
in the diagram. At A the positions of the two suns will coincide. Near A the radius vector being greater than its mean value, it shall describe in a unit of time less area and therefore the daily angular motion of the real sun is less than the mean value. Consequently in passing from A to P the real sun will be on the west of the second imaginary sun as is shewn in the positions III and IV, and the equation of time due to this cause is negative in this part. At P the positions of the two suns will again coincide. We now examine the relation between this second imaginary sun moving in the ecliptic with the true sun's mean angular velocity, namely, 59m-8s., and the imaginary sun called the mean sun moving along the Equator with the same angular



velocity in order to find out the effect due to the obliquity of the ecliptic. Let *r* C ≏ denote the northern half of the ecliptic and *r* M ≏ the corresponding half of the Equator. Suppose the second imaginary sun and the mean sun to start simultaneously from *r* and let S be the position of the former at any time between *r* and C the summer solistice. Draw S n perpendicular to the Equator. Then *r* n is the R. A. of the second imaginary sun. The R. A. of the mean sun is *r* M_1 which is equal to *r* S, for the two suns are supposed to move with equal angular velocity, and since in the right-angled triangle *r* n S the hypotenuse *r* S is greater than the side *r* n_1 therefore *r* M_1 is greater than *r* n. Hence in coming to the meridian the mean sun is behind the imaginary sun moving in the ecliptic, or the equation of time due to this cause is negative in this part. But when the latter is at the summer solistice C the R. A. of the two will be equal, and they will cross the meridian at the same time.

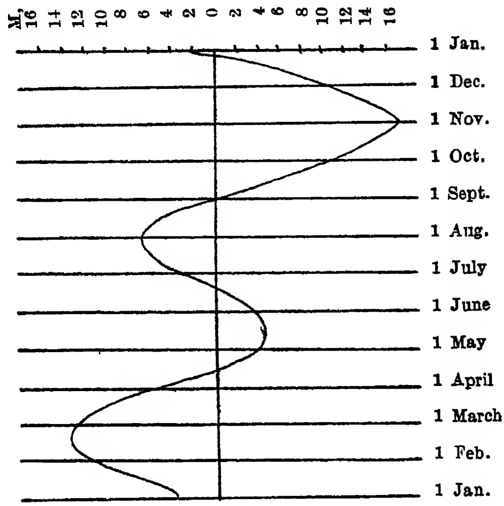
Similarly, it can be shewn that from summer solistice to ≏ the mean sun is ahead of the imaginary sun in crossing the meridian, and hence the equation of time due to this cause is positive in this part. Also it can be shewn that the mean sun is behind the second imaginary sun from ≏ to winter solistice, and before from winter solistice to *r* and

consequently the equations of time in those two parts, due to the obliquity of the ecliptic, are respectively negative and positive. In order to understand properly the diagrams of curves of equations of time, it is necessary to mention that the times of the sun coming to vernal equinox, summer solistice, autumnal equinox and winter solistice are 21st March, 22nd June, 23rd September and 22nd December respectively, and the greatest value of the equation of time due to the unequal motion of the sun of the ecliptic is 8m., and that due to the obliquity of the ecliptic is 9m.-53s.



From what has been said before, we find that the equation of time due to the unequal motion of the sun in the ecliptic is positive from 3rd January ; it attains a maximum value of about 8m. in the beginning of April and then vanishes on the 3rd July. After this it becomes negative, and the negative value increases till the beginning of October. It then decreases, and finally vanishes on the 3rd January. As regards the second cause, namely, obliquity of the ecliptic, the equation of time vanishes on the 21st March, after which it becomes negative, and attaining its maximum value 9m.-50s., diminishes gradually and vanishes entirely on 22nd June. After this it is positive, and passing through its maximum value vanishes a second time on 23rd September. It then becomes negative and vanishes for the third time on 22nd December. After this it becomes positive and vanishes for the fourth time on 21st March. The combined effect of

these two causes will give us how much the true sun is behind or before the mean sun, or in other words the difference between the apparent solar time and the mean solar time. It is found that the equation of time vanishes four times a year. At present these dates are 16th April, 15th June, 2nd September and 25th December, *i.e.*, on these days the



mean solar time and the apparent solar time coincide. The maximum values of the equation of times and their dates are + 14m.-25s. on 12th February, – 3m.-49s. on 15th May, + 6m.-20s. on 27th July, and – 16m.-21s. on 4th November. Thus the relation between the apparent solar time and the mean solar time is known, *i.e.*, how much the apparent solar time precedes or is behind the mean solar time, and the observation of the real sun gives us directly the apparent solar time. Hence we are able to deduce the mean solar time, *i.e.*, our true clock time, by the application of equation of time to the apparent solar time.

Some of the Physical Features of Mars.

By H. G. Tomkins.

I have written this short paper in order to set before members some little account of the suggestions regarding the planet Mars made by Dr. Lowell of Flagstaff Observatory, America, who has just presented the Society with a set of his unique photographs of that planet which he contends sets at rest once for all the question of the existence of the canals on Mars.

Mars is the planet which is probably better known to us than any other of our system and is, reckoning outwards from the Sun, the next to the Earth. It is much smaller than the Earth, the diameter being only 4,220 miles as compared with the Earth's 7,919 miles. The mass of Mars is much less than that of the Earth, and as a consequence air and water cannot be present there in anything like the same quantities as on the Earth, even if they are there at all.

Since a telescope was first turned on Mars, it has been possible to see certain dusky markings and light patches, notably perhaps the two white patches at the poles of the planet. It was not until 1877, however, that an observer appeared who systematically made this planet a subject of study. In that year Schiaparelli, the great Italian astronomer, in scanning the surface of Mars discovered long narrow markings which had never been seen before, and for want of a better name he called them canals, though he had no thought then of using the term in the present sense of the term. These lines he found to run in various directions all over the planet, and before he died he had discovered 113 canals. Another observer also appeared in the field in the person of Dr. Lowell, who has just presented us with the photographs we have to show this evening. He has been able to increase the number of canals to 437 in number, and to add many other details regarding the features of the planet to our knowledge. In 1894 one of the canals was noticed to be double, and this peculiarity has now been found to belong to others also. Lowell has also noticed that the canals all emerge from the area surrounding the Polar Caps, and that they proceed towards the Equator. Where they cross there is almost invariably what he calls an oasis.

The above is a very brief outline of what Lowell has seen in Mars, and on these data he has built up an exceedingly ingenious theory of the physical condition and life in Mars to

MARS 1909.

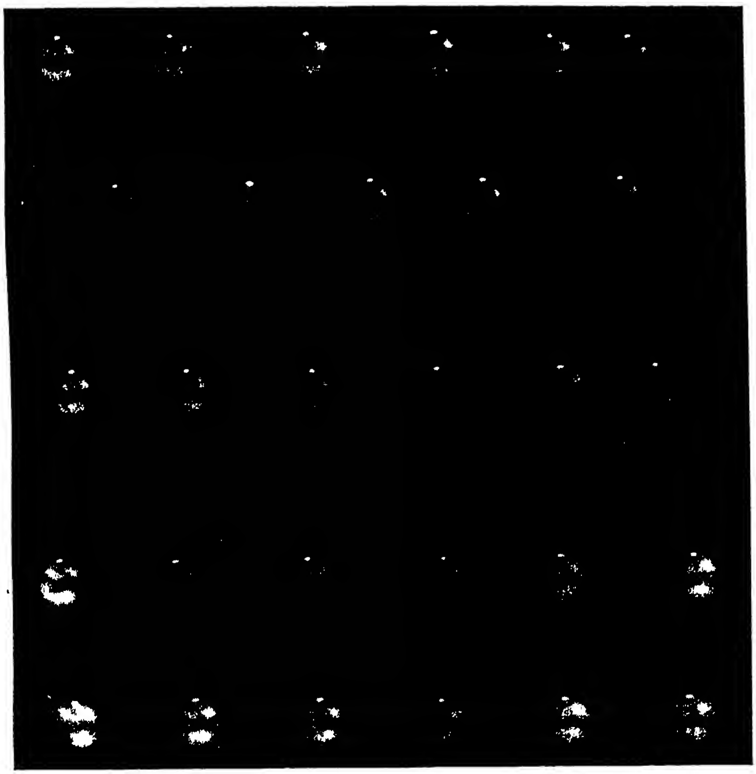


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911

Photographs of the planet Mars taken at Flagstaff Observatory by Mr. E. C. Slipher, on 30th September 1909, sent to the Society by Dr. Lowell, Director of the Observatory.

account for it, taking his ideas from the Earth and what he considers has happened or is likely to happen in the year. It is admitted that air and water in Mars cannot be anything like so plentiful as in the Earth, and from his calculations and observations he concludes that the equatorial regions of the planet are probably deserts, but that water and snow do exist at the poles, and in fact that the white caps there are snow. He finds that these caps at certain seasons of the year corresponding to the Martian summer decrease in size, and that this decrease is followed by the appearance of a darkening round the caps and from this ring later on the canals appear and extend towards, and some of them over, the Equator. His view is that these lines are in fact connected with canals such as we know them and that they represent a vast irrigation system in Mars. The canals take the water from the melted snows from the Polar regions to the desert areas in the equatorial part of the planet, and on each side of these canals vegetation—perhaps crops spring up, thus causing the dark streaks across the yellow sandy desert which are seen. Where the canals cross, it would be natural to find a patch of the same vegetion. We are of course familiar with this state of affairs in India if for the Polar Caps we substitute the Himalaya mountains, and those who take the trouble to read his book on Mars, which is in our Library, will certainly say that he has made out what looks like a very strong case in support of his theory. The idea of course pre-supposes the existence of intelligent beings on the planet, and these Lowell considers do exist there; indeed if canals do exist there in the manner suggested by him, they must be far more capable engineers than we have here on the Earth.

Such, broadly, is the theory of Dr. Lowell. As members are of course aware, this theory has been, and is likely to be, the subject of very considerable criticism and disagreement among astronomers. For many years it was not admitted that the canals had any existence at all in fact; even now many hold that they are an optical effect produced by a small disc and a tired eye. This having been the case with the canals themselves, it is perhaps hardly necessary to say that it was much more so with the contention of their duplication, and many theories have been brought forward to show that a slight error in focussing would produce the effect. Granting the visibility of the canals, the theory of Dr. Lowell to account for them has been strongly opposed on several grounds, the most important of which are that water does not probably exist on the planet, and if it did, that under the conditions of Mars the

canals would have to be of such immense depth to carry the water to the equatorial regions that it would never reach the surface. This is perhaps the strongest argument of any against the theory, and is one which it is very difficult to get over without supposing the Martians to possess some extraordinary means of pumping or raising water such as we cannot conceive of. This at once takes us into the realms of speculation and beyond the limits which most people are wlling to go.

In order to prove the existence of the canals and so put to silence the objections on this ground, Dr. Lowell has resorted to photography, and whatever may be the views of those who consider his theories, it must be admitted at once by everyone that these photographs are of an excellence which has never yet been approached by anyone else. The detail on them and the definition which has been secured are alike wonderful, and they mark a great and important advance in planetary photography. They have been shown recently in England before the Royal Society, the Royal Astronomical Society, as well as the British Astronomical Association. Reports, however, appear to show that although the wealth of detail was recognised, no very decided opinion was expressed in the visibility of the canals; and on carefully examining the photographs sent to us, I must admit that I cannot see any clearly marked streak which would correspond to a canal, though there are certainly one or two broad lines projecting from the dark areas. A transparency, however, is a very difficult thing to produce, and Dr. Lowell assures us that the canals are visible on the photographs, and on a print which he kindly sent me some years ago there certainly were linear markings. Considering the far better seeing conditions at Flagstaff than most places elsewhere, it seems to me going rather far to practically declare Dr. Lowell's observations to be the result of imagination, whatever may be thought of his theory. Consequently, while perhaps keeping an open mind as to the probability of the irrigation system and life on Mars, I think it must be admitted that far more detail has been discovered by Dr. Lowell than some people are willing to accept. As opposed to the canal system, the Director of the Mars Section of the British Astronomical Association declares the lines really to consist of series of dark patches, which, owing to a less powerful instrument than he himself used, appeared to Schiaparelli and Lowell and other observers as lines. The map of the British Association which he has drawn up from the observations of the sections, however, does not seem to me to

support this view. The above is a very brief account of the work in connection with which these wonderful slides sent us by Dr. Lowell were taken, and in setting it forth I have endeavoured to indicate, as far as possible, the present state of opinion regarding the question as to whether the markings on Mars indicate the existence of intelligent beings on the planet, and whether the canals are the work of their hands or not.

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the month of June 1911.

Siderial time at 8 p.m.

				H.	M.	S.
June 1st	...	...	...	12	35	49
,, *8th*	...	...	...	13	3	25
,, *15th*	...	...	...	13	31	1
,, *22nd*	...	...	...	13	58	37
,, *29th*	...	...	...	14	26	13

From this table the constellations visible during the evenings of June can be ascertained by a reference to their position as given in a Star Chart.

Phases of the Moon.

			H.	M.
June 4th	First Quarter	.	3	34 a.m.
,, *12th*	Full Moon .	.	3	21 a.m.
,, *20th*	Last Quarter	.	2	21 a.m.
,, *26th*	New Moon .	.	6	50 p.m.

Meteors.

		R. A.	Dec.	
May—June	. .	235°	+ 9	Rather slow.
May—June	. .	280°	+32	Swift.

Planets.

Venus.—Is an evening star. The time of its setting is 9 h. 25 m. p.m.

Saturn.—The position of this planet on the 15th June at 8 p.m. will be R. A. 2 h. 53 m. 55 s. Dec. 14°-20′-45″ N. Time of its rising 2 h. 31 m. a.m. on the 16th June.

Mars.—The position of this planet on 15th June at 8 p m. will be R. A. 0 h. 36 m. 53 s. Dec. 1°-46′-9″ N. Time of its rising will be 0 h. 36 m. a.m. on the 16th June.

Jupiter.—The position of this planet on the 15th June at 8 p.m. will be R. A. 14 h. 13 m.-2 s. Dec. 12°-2′-49″ S. The time of its setting will be 1 h. 59 m. a.m. on the 16th June.

Correspondence.

DEAR SIR,

With reference to the bright spots in the trail of the meteorite, the photograph of which has been before the Society, I imagine a meteor to be a part broken off some other body which is travelling in its own orbit, and this broken part, which must necessarily be an outside portion, and consequently more or less of a crescent shape, according to its relative size to the object from which it came, is thrown off at a tangent at the same pace at which the original body is travelling. If this portion were a sphere, which it cannot be, unless the original object were in a molten condition, it would spin; but if it were a crescent or uneven-shaped figure, it would go in a spiral on account of one side being heavier than the other.

The asteroids, I take it, are spheres and spin round an orbit, but a meteor has no orbit. To take an example. If one drives along a road on which there is a surface layer of mud, and some of the mud adheres to the wheel of the carriage, the wheel, in turning round, throws off flakes of mud. If these flakes of mud were thrown high enough, would they fall straight down to the ground again, or

would they have a tendency to turn over in falling? I rather think they would turn over, and the further they have to fall, the oftener would they turn. The same with a meteor. I suppose, in order to find this out, one should have a cinematograph camera attached to a telescope, but then the difficulty would be to set it going just when the meteor is there. Here is a suggestion for the dim future, when the Society will have got together enough funds!

Yours Sincerely,

ETHEL VOIGT.

[The above would no doubt account for the bright patches in the trail, but the shape of a meteorite would be roughly spherical as a crescent shaped body which, nobbled in the manner suggested, would not obey the laws of equilibrium in its orbit. It seems probable that the bright patches are due to the trail doubling back on itself owing to air currents. At the overlapping places a patch would appear.—H. G. T.]

Extracts from Publications.

Mr. Hollis, writing to the *English Mechanic* regarding a paper by Mr. Holmes of the British Astronomical Society, says:—

Mr. Holmes asks for what reasons do we believe, or are there good reasons for believing, that meteors are visible because they ignite by friction, and is our atmosphere sufficient to prevent them arriving with some force on the Earth? Mr. Holmes gave figures showing the equivalent of the whole atmosphere between the meteor and the surface of the Earth expressed in volume of air at surface density, which did not amount to very much, and asked with some humour whether anyone would care to stand with only that between him and the muzzle of a loaded gun? In the discussion which followed—and this paper called forth some valuable remarks—the opinion was expressed that perhaps sufficient account had not been taken of chemical action; also it was pointed out that the immense velocity of the meteors increased rather than diminished the resistance of the air, but the feeling was evidently pretty general that Mr. Holmes had touched a weak spot, and that this statement about the incandes-

cence of meteors by friction had got into the text books without much in the way of definite proof.

[*English Mechanic.*

Mr. Thorp writes in the *English Mechanic* :—

How do we know that the atmosphere is one-millionth of sea level density at seventy miles high? We are situated somewhat as a fish would be in an ocean five miles deep, which, finding the pressure five tons on the square inch, and rising to two and a half miles found the pressure only two and a half tons, argued that the next two and a half miles would reduce this by a ton and a quarter, and so on, and that at each rise of two and a half miles the pressure would be reduced one half to any height. This would be an error, as we know, since the pressure of the water would cease at the surface; but the fish would not be able to reason thus, and to me we appear to reason fish fashion. As we cannot get up the second three and a half miles even to test the question what evidence is there that the atmosphere has not a definite surface at, say, ten miles high? There is much evidence from analogy that such definite surface exists, for, as the Sun, Jupiter, and Saturn are all gaseous—specially the Sun—and they all present sharply defined limits to their atmosphere, we are entitled to argue a smaller body, like the Earth, must also have a limited envelope. Full stronger evidence is offered by Venus. In her case we never see anything but her atmosphere, illuminated by the Sun, and her atmosphere presents a very hard, definite outline, showing that it certainly does not thin out in the manner the Earth's atmosphere has been supposed to do. Let us suppose that our atmosphere ends at ten miles. Its density will be enormously greater than Mr. Thomson supposes at seventy. In fact it would be at least half the density at sea level, and a meteor would strike it with tremendous energy, and the resistance be great enough to volatilise the whole. I submit that the calculated heights are very rough and of no value, because it is impossible to obtain distance from a single observation; and when two observers have supposed they saw the same meteor, I suggest, in fact, they saw two different ones, and thus deduced an enormously erroneous height. The observations of position are necessarily grossly inexact, and a very slight difference of displacement would account for getting seventy miles instead of ten.

[*English Mechanic.*

Mr. Hollis, writing to the *English Mechanic*, says :—

I think we must accept the computed heights of meteors. The accumulation of results, showing that the paths are fifty or sixty miles above the earth, makes it clear that this is not far from the truth, for errors of observation would not conspire to agree in that way. Secondly, determinations of the height of the atmosphere from the observed length of twilight gives it a limit of about 200 miles, so that there is probably something in the way of atmosphere at a height of 70, though it may be attenuated. Thirdly, the effect of the great velocity of the meteors in causing resistance must not be under-estimated. Resistance varies as the square of the velocity. This is a fact proved for comparatively small velocities by direct experiment with projectiles, and also by comparison of wind pressures with velocities. In some figures, referring to a great storm that I have now before me, when the velocity of the wind was 88 ft. per second, the pressure was 18 lb. to the square foot; therefore, by the above law, if the velocity had been 40 miles per second, the pressure would have been $(40 \times 5280\text{-}88)^2 \times 18$ lb. $= 103,680,000$ lb. per square foot; so that, if we reverse the operation, and suppose the pressure created by the motion of the meteor rather than by the motion of the air, the pressure caused, even in an attenuated atmosphere, must evidently be large. The question is not new. In a book on *Meteoric Astronomy* by Kirkwood, published in 1867, it is written :— "This question has been discussed by Joule, Thomson, Haidinger, and Reichenbach, and may now be regarded as definitely settled. A velocity of 30 miles a second would produce a temperature of 2,500,000°." He does not give all the data and figures for this result, or I should be glad to quote them; but I have no doubt that they were at least as trustworthy as those of Mr. Thomson, who evidently was taking extreme cases on the opposite side. Haidinger's Memoir is in the British Association Report for 1861, with a note by Mr. Greg, and in that there is a suggestion that the light emitted by fire-balls does not arise from mere incandescence, but is caused by electricity; so, though as I think we may take it, the appearance of shooting stars is caused by motion through an atmosphere, causes other than incandescence may be considered.

[*English Mechanic.*

Mr. Eddington, in explaining a paper on the Principle of Relativity as applied to Astronomy before the Royal Astronomical Society, said :—

Dr. de Sitter's paper is largely occupied with mathematical investigations, and as the subject is probably not very familiar to astronomers generally, perhaps I had better begin by explaining a little about the Principle of Relativity, why we need such a principle, and why there is reason to believe in it. It is well known that physicists now are inclined to attribute the property of matter called mass or inertia to an electrical origin. If this hypothesis is true, then the mass of a body is not strictly constant, but contains a term depending on the square of the velocity. The extra term is very small, but yet, in the case of a planet which is moving very fast, it may just become appreciable in astronomical measurements. If we take Mercury, which is moving fastest, and which also has a large eccentricity, its mass would change between aphelion and perihelion by something of the order of one part in fifty million in consequence of the change in its velocity. This is just on the verge of what might be appreciable in astronomical measurements. Now we could put this term into the equations of motion, and work out the result quite independently of Relativity, simply assuming the electrical nature of matter. But we run up against a difficulty at once. What shall we assume for the more accurate law of gravitation? The law of gravitation, as ordinarily expressed, depends upon the product of the masses; and if we begin juggling with the idea of mass in this way, it involves a reconsideration of the law of gravitation, for the phraseology of the accepted law has become ambiguous. That is where the Principle of Relativity helps us. It asserts that it is impossible in any system to detect the uniform motion of that system through æther. That is not an accurate definition, but that is what practically it amounts to. If you prefer a really scientific definition, I may quote from Dr. de Sitter's paper: it is "the postulate that the transformations with respect to which the laws of nature shall be invariant are Lorentz transformations."

Now why should we believe in this principle? You will see, of course, that it does indicate to us in a way a new law of gravitation, because it asserts that the alteration in the masses produced by the motion of the whole system through space (introducing that little extra term) is compensated by other changes in the equations of motion, including, of course, the law of gravitation. The

reason why we think there is some probability in the Principle of Relativity is because it is always found by experiments, undertaken to detect the motion of our system through the æther, that there is an exact compensation. Moreover, it has been proved that for a very large class of natural phenomena this compensation occurs in the actual fundamental laws themselves—the laws of electrodynamics—and so prevails in all phenomena which depend on those laws.

[*The Observatory.*

The Harvest Moon is not generally understood by the public, but the true cause has long been known to astronomers and can be very easily explained. It arises from the fact that the ecliptic or the Sun's apparent path through the heavens is variously inclined to the horizon at different seasons of the year. The celestial equator is always at the same angle with the horizon, and hence equal portions come above the horizon in equal periods of time. If the Moon moved in the celestial equator, she would rise and set directly in the east and west points of the horizon respectively, and she would rise later each night by a nearly constant interval. But the Moon moves in a path which is constantly inclined to the ecliptic at an angle of about 5 degrees, though for the present explanation she may be regarded as moving in the ecliptic; and as the ecliptic is inclined to the celestial equator at an angle of 23½ degrees, the Moon in all parts of her orbit does not rise at equal intervals on each succeeding night.

[*Popular Astronomy.*

Notices of the Society

Election of Members.

The attention of members is invited to Bye-law No. 14, regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherji.

The Library.

An opportunity will occur during the next few months, owing to one of the members of the Society going to

England, of obtaining books cheaply there for the Library. A subscription list has already been opened, and several members in Calcutta have subscribed and enabled the Council to make a beginning with the Library. Other members outside Calcutta, however, have not yet come forward, and as the Library will be one of the most important adjuncts of the Society, and will be available to members both in and out of Calcutta, those who have not done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

A number of books have already been received and can be borrowed by members in accordance with the Bye-laws.

The books available can be ascertained from the Assistant Librarian and a catalogue will issue shortly. The reading room of the Society in the Imperial Secretariat is now opened for the use of members daily from 5 to 7 p.m. except on Wednesdays and holidays, and from 3 to 5 p.m. on Saturdays, unless that day is a holiday.

Subscriptions.

Some of the subscriptions are still due for the current session from members. Those who have not yet done so are requested to remit the amounts to the Treasurer.

The Treasurer will also be glad to receive those donations promised for the Library and quarters which have not already been paid, as the Council wish to take full advantage of the promised assistance as soon as possible during the present session.

Instruments.

The President as well as the Director of Instruments will be in England for a short time this summer. They will be happy to assist any members who desire to purchase second-hand instruments by inspecting the instruments for them if they will communicate with the Director at once.

Papers for Meetings.

It is requested that drawings which accompany papers for reproduction in the JOURNAL may be made with Indian ink on white paper. This will insure a clear reproduction.

Meetings.

The ordinary meetings of the Society will be held on the following dates :—

1911.

May 30th	June 27th

The meetings will commence at 5 p.m. and, until further notice, will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

(2) *Secretary (Scientific)* . W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.

(3) *Do. (Business)* . P. N. MUKHERJI, M.A., F.S.S., Imperial Secretariat Buildings, Calcutta.

(4) *Treasurer* . . . U. L. BANERJEE, M.A., Office of the Acctt. General, Koila Ghat Street, Calcutta.

(5) *Librarian* . . . ASHUTOSH MITTRA, M.A., 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.

(6) *Editor* . . . CHAS. T. LETTON, 8. Hastings Street, Calcutta.

(7) *Directors* :—

General Section . . DR. E. P. HARRISON, Ph.D. Presidency College, Calcutta.

Lunar Section . . H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.

Meteor Section . . B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.

Variable Star Section . LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., Dehra Dun.

Photography . . R. J. WATSON, 37, Park Road, Barrackpore

Instruments . . S. WOODHOUSE, 15, Wood Street, Calcutta.

The Journal of the Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 8.

Report of the Meeting of the Society held on Tuesday the 30th May 1911.

H. G. TOMKINS., F.R.A.S., *President*, in the Chair.

The usual Monthly Meeting of the Astronomical Society of India was held, in the Imperial Secretariat Buildings (ground floor), on Tuesday the 30th May 1911.

The Minutes of the previous meeting were read and confirmed.

The President then announced that six presents had been received by the Society, including a valuable addition of six works to the library from Sree Rajah A. V. Jugga Rao, Bahadur Garu, F.R.A.S., &c.

The thanks of the Society were accorded to the donors.

The election of the following members by the Council was then confirmed :—

1. MR. S. C. GHOSE, M.A.
2. MR. C. T. LETTON.
3. MR. B. N. MITRA, ESQ., B.A.
4. NAWAB WAHIDUDDIN, KHAN BAHADUR.

It was then announced that the Royal Astronomical Society of Canada had placed the Astronomical Society of India on its list of Exchanges, and a congratulatory letter from that society was read. A hearty vote of thanks was accorded to the Royal Astronomical Society of Canada for their letter and good wishes.

The first paper of the evening, on the Grinding of a Glass Specula, by Mr. Dhar, was read by the President, while Mr. Rakshit took the Chair, owing to the absence of Mr. Dhar, who however attended late and took over the reading of his paper from the President.

Mr. Woodhouse.—What is the object of the iron squares instead of the glass tool ?

Mr. Dhar.—With a marble slab and the squares, it is not necessary to grind the slab to the curve of the mirror, and so the slab can be used more than once and the arrangement is economical.

Mr. Woodhouse.—Is it possible to get a true curve in this way ?

Mr. Dhar.—I think that it is possible, yes. The marble slab can be utilized by merely placing a small bit of iron or glass carefully on it with pitch. Of course you must be careful so to place the pieces of glass that they take the curvature.

The President.—I suppose you have to work those pieces down to the curvature of the mirror after pressing them to the shape of the mirror ?

Mr. Dhar.—When the grinding is done I make, first of all, a slab with the grooves and I square it out by lines. I put square bits of glass or iron on this and as soon as the mirror is worked upon those pieces, they take the concavity.

Mr. Dhar then explained his meaning by drawings on the blackboard.

The President.—Would you not find it much easier to just take two pieces of plane glass and then grind them one over the other until they became concave and convex ?

Mr. Dhar.—If I press down the pieces they will take the shape of the convex tool; they then have to be ground with a shaper till the approximate curve is reached and after that the mirror is put on.

The President.—Do you let your square of iron or glass rest in the pitch itself ?

Mr. Dhar.—Yes.

The President.—You do not press them down to the iron or marble disc ?

Mr. Dhar.—No.

The President.—With the square resting in the pitch is the arrangement not liable to destroy the curvature of your mirror owing to the squares getting out of position ?

Mr Dhar.—Of course it has to be carefully looked after.

The President.—Then it is not a permanent tool, and I take it that it is liable to get out of shape ?

Mr. Dhar.—Of course it may get out of shape. Now and then that has happened; but this is purely for grinding purposes. When the fine grinding is done, of course, if too long intervals are allowed to pass between one grinding and another, that result may take place. The plan is an alternative to avoid making a convex tool for each mirror, and so is economical.

The President.—Now that we are on the subject I should like to give you an outline briefly of a simple way of making a glass specula. About 15 years ago I made a reflecting telescope myself. Now I will just show the drawing on the board. (Drew a sketch on the blackboard.) You just simply obtain two pieces of glass 6" in diameter and cut into circular discs ; then edge them. Mr. Dhar used a lathe. Without a lathe you get the discs and stick two pieces of wood on each face of the disc with pitch, fix it up between two supports, get a piece of string and wind it round, so as to spin it between the supports. Now with a piece of curved iron, grind the edge with a rough grade emery or carborundum and water, and then when you have finished with that, you use the finer grade. Then just bevel the edge of the mirror. Next, having got your two pieces of glass the same size, fix one to the top of a tube or post. The mirror can be stuck down with pitch. To warm the mirror for the pitch, boil it. Do not heat it with a lamp unless you wish to crack it. In the same way stick a piece of wood on the other glass for a handle, and all you have to do then is with long strides to grind one of your discs over the other with carborundum, and water, and walk round your post all the time that you are grinding. As you get away round just give the mirror a spin round at the same time. You will find that the piece underneath will become convex and the piece on top concave. The latter will be the mirror. Then you have got to fine-grind it in the same way as described by Mr. Dhar. If you wet the surface of the mirror and flash the image of the sun on a wall, then measure the distance from the mirror to the wall, you can obtain roughly the length of the focus. If it is too long you can go on again, but it is better to keep on the long side in the early stages and shorten as you fine-grind. With a 6″ mirror I should make the telescope

about 5 or 6 feet long. As soon as you have done that, do away with your coarse emery and use a finer emery, and then use flour emery as described by Mr. Dhar. When you think you are through with that you will find that your mirror is so fine ground that you will be able to see anything on the other side. Then the polishing. The simple way with a small mirror of this kind is to get a piece of nice paper and stick it evenly over the face of the tool. See that it is without any crease and with the stem of a wine-glass rub it well down all over. Then you must wash the rouge and brush over the paper with a brush; then rub in again with your wine-glass stem till you get it nice and smooth. On this a polish will come on the mirror in about two hours. Now test it. The method, you will remember, was fully described by Dr. Harrison in his paper in a recent number of the JOURNAL. If any one would like to send me a mirror which they have made I would be glad to test it for them.

Mr. Dhar.—You said that the paper must be spread all over the whole of the tool uniformly and then used for polishing. I once tried that, but I met with utter failure; perhaps it was not evenly put over the glass.

The President.—Yes, you must be very careful; it takes about two hours to put it on and rub it down.

Mr. Dhar.—Several years ago a paper was published in which I read that some one had tried it but had never met with any success with paper polishing.

The President.—Mr. Woodhouse knows something of paper polishing. Do you use paper polishing?

Mr. Woodhouse.—Paper is used to bring up a polish, but the work is usually finished off with pitch.

A hearty vote of thanks was returned to Mr. Dhar for his interesting paper.

The next paper of the evening was read by Mr. Bannerjee on the Lunar View of the Apennines. He explained his remarks by some very interesting lantern pictures. A vote of thanks was duly returned to Mr. Bannerjee.

Mr. Rakshit then read a paper by Mr. Ashutosh Mitra on the Solar eclipse of October 1911 and explained his figures on the blackboard.

The President.—Does that shade show the magnitude of the eclipse? I thought it would be more.

Mr. Rakshit.—Yes.

The President then drew a sketch on the blackboard illustrating a simple way to see this eclipse.

The President.—The magnitude of the eclipse is about ·64. Mr. Rakshit's figures are just a rough sketch of what we are to have, but members are working on it and will submit their results later on.

The President next showed a few photographs of the moon which he had taken during an investigation two or three years ago and which brought into prominence some interesting facts regarding the moon.

The President.—The part of the moon which I wish to draw your attention to in this first photograph are these bright rays, running from Copernicus and Tycho. These slides bring out clearly to you the fact that the same rays do not appear the same on them all, but vary very much on the different slides. The slides represent the moon at different ages, and so we see that the prominence of the rays varies with the time that part of the moon has been under the sun's rays. The problem which is before us is whether the variation in the rays is due to some physical cause in the rays themselves or whether it is merely a matter of illumination. I think the question is pretty well settled. The portion of the moon's surface in which I have chiefly investigated the subject is Copernicus, and you see no rays at all in the earlier stages of the illumination. For a space of 1½ to 2½ days you do not see rays at all, and the same thing occurs just before sunset again. Observations show that these are surface markings; there are no high ridges; there are ridges but not very high ones; the brightness is due to surface conditions. Now the question is whether these surface markings vary owing to some physical cause or owing simply to difference of illumination. I think that there is no doubt at all that it is a cause of light and not a question of physical change. The experiment which I first made was to make a model of a ray system very roughly on a board, and then with the aid of a magic lantern and a bright aceteline lamp I threw a strong light on the model so as to reproduce the conditions of the rising sun on the moon. I then photographed the rays at the various angles, and the results I got, as you see from the slides, were to show that as the illumination became vertical the rays appeared clearly, but as it became oblique they died away. You will notice that the model rays are practically invisible when the angle from the model is 9·5°. This agrees with the usual angle (10°) at which the sun's altitude usually stands when the

rays become visible on the moon; and this is the point which I wished to bring forward this evening. I have 3 records of the rays having been seen even at the dark part of the moon, and that goes to show that these rays do not change physically, but that the variation is merely a question of waxing or waning light. The rays have also been seen by me in the Earth-light as well as on occasions of a total eclipse of the moon.

Mr. Simmons.—Do you think this explanation applies to the white spots also?

The President.—There is a probability that it does. The only thing about a white spot is, as a rule, that it is an elevation, but taking this into account the same thing ought to apply to a mountain range or a slope.

The President.—Before we close our meeting this evening I would mention that we have a rule about the election of the Council, and names proposed by members will have to be sent in by the next meeting, which will end the present session. A list of members will be sent to members with the next number of the JOURNAL.

The President then adjourned the Meeting to Tuesday the 27th June 1911 at 5 p.m.

On the Construction of Glass Specula for Reflecting Telescopes.

BY N. N. DHAR.

Reflecting telescopes have been popular with amateurs and are likely to be so, I may say, always. The reason is that they are easier to make; I mean the principal part of them, namely, the object mirror or speculum. Besides, as the object mirror forms the image by reflection, there is no colour trouble due to what is called "chromatic aberration," which is a source of annoyance with refracting instruments.* Another great advantage with reflectors is (in the case of their most popular form, the Newtonian) that the observer is always comfortable in his position, as he has never to look up but always looks down or straight forwards. In these few introductory remarks, I do not

* Reflectors are not, however, altogether free from chromatism, which is introduced more or less by the lenses in the eye-piece.

propose to institute any comparison between the two forms of instruments, the reflector and the refractor, but I only state the reasons why reflectors are popular with amateurs, who can, if so inclined, make their own instruments. The cost of making them is also much less than that of making refractors.

I have said before that an object mirror is easier to make. This is because in a mirror only one surface has to be dealt with, while in the case of an object glass for a refractor (which is generally a combination of two glasses of different kinds) four surfaces have to be operated upon.

It is not to be supposed, however, that a good telescopic mirror is so easy to make. I merely mean that the difficulties are less. Months, nay, years of patient work are necessary before one can achieve a fair amount of success in finishing object mirrors. A good many years ago Sir Howard Grubb in a lecture on "Telescopic Objectives" said that "no one could learn the process under nine years' hard work." A finished object glass (or object mirror) is, according to the same authority, "more a work of art" than a product of mere mechanical operation. I am quite sure that workers in this field will agree with me when I say that none but enthusiasts can overcome the difficulties in this "fascinating and exasperating pursuit," as Mr. Buchanan observes in his interesting paper on the subject in the March number of the JOURNAL.

I will now proceed to give some practical hints on the construction of glass specula. As is well-known, formerly metallic specula were much in use; they have in modern times been replaced by the silver-on-glass mirrors. In this paper I intend to deal only with the latter. After the glass disc is selected and rounded, the process of making it into a speculum or mirror consists of four stages; they are, according to their sequence, (1) rough grinding, (2) fine grinding, (3) polishing, and (4) figuring. It is the last process which is the most important and exacting.

First of all the glass must be selected. It must be sufficiently thick so that there may be no flexure when it is tested during the figuring process by standing it on end. The usual rule is that the thickness of the glass should be one-sixth of its diameter. Even a thickness of one-eighth may do.* I have never met with any trouble with my

* Mr. Buchanan's 16″ mirror is 2·5 inches thick; one-sixth thickness would be 2·7 inches; so that the thickness is very nearly one-sixth the diameter. The fear I had occasion to express in regard to this mirror at the February Meeting was not therefore well founded. I earnestly hope that the mirror when finally tested will be found to be perfect.

eight-inch mirrors of one-inch thickness. For mirrors up to eight-inch thickness the quality of glass is not of much moment; good plate glass of the required thickness should be used and such glass is always available in Calcutta.

Then the glass must be roughly cut into a circular shape. This can be conveniently done at the glass seller's when purchasing the glass. The glass must now be attached to an ordinary lathe so that it turns on a horizontal axis. The edges are then smoothed by being ground with ordinary coarse sand and water supplied on an iron band just pressing against the edge of the glass. When the edge is sufficiently smooth, it is better to grind it with finer and finer sand of grades up to thirty minutes as described below. These are prepared from the mud that collects when grinding with ordinary coarse sand. This mud being vigorously stirred in a deep vessel nearly full of water, is allowed to settle for 5 seconds. The water is then gently poured off into another vessel leaving the sediment at the bottom. This sediment is preserved and called "5 second sand." From the muddy water that remains we get by a similar process grades of sand of ½ min., 1 min., 5 min., 15 min, 30 min. and 60 min. All these grades of sand are carefully bottled and kept apart.

When the glass is nicely edged, it is now ready for the next stage, namely, the hollowing out of the surface to the required curve, a convex iron or brass gauge for which is prepared beforehand. The focal length of the mirror should be about nine times its diameter, so that the gauge is of a radius of curvature eighteen times the diameter. Besides this *convex* gauge, another gauge of the same radius of curvature but *concave* should also be made, as it will be required for future use.

The hollowing-out may be done by placing the intended mirror face-up and grinding it with a circular piece of glass plate of half its diameter. The abrading material used is coarse sand mixed with water placed between the glass surfaces. Carborundum may be used at this stage with advantage. During this process the glass for the intended mirror should be placed on a wooden bed having a small hole at the centre. This hole loosely fits round a pivot fixed on the surface of a table, so that the bed along with the glass may be turned round in its place on the table from time to time. The smaller tool should be firmly held by means of a wooden knob attached to its back with melted pitch or resin and moved forwards and backwards (in *straight* strokes), as well as round and round (in *circular*

strokes), over the glass, care being taken that the tool does not go beyond the edge of the mirror-glass. While giving these strokes the tool should also be constantly rotated with the hand as also the mirror itself, but less frequently.

When the grinding is carried on for some time in this way the surface of the intended mirror will be hollowed out into a concavity. From time to time this concavity must be measured by placing the convex gauge edgewise across the middle of the glass. When it is found that the gauge fits the concavity, further grinding with coarse sand must be stopped. This finishes rough grinding.

The mirror should now be removed from its wooden bed and kept apart, as all future operations will have to be made with the mirror face *down* and not *up*.

The fine grinding has to be done now. For this purpose a new tool should be made. A circular slab of marble half an inch larger in diameter than the intended mirror and about an eighth of its diameter in thickness should be procured. One surface of this should be turned on an ordinary lathe to a *convexity* of the same radius of curvature as the *concavity* of the intended mirror. The convexity of this surface should be tested by the *concave* gauge prepared before.* A quantity of pitch or resin being melted in a vessel should now be poured on the convex face of the marble (which face should be slightly warmed previously over a fire) and spread uniformly *all over* this face about a quarter of an inch thick. The hollowed face of the mirror shall now be smeared all over thoroughly with water and placed over the pitch or resin surface and pressed down more or less so that the said surface fits the concavity of the mirror. The mirror should then be removed. Next, a number of bits of glass one inch square and about a quarter of an inch thick should be procured and slightly heated and placed in rows over the pitch surface of the marble slab about $\frac{1}{8}$ inch apart from each other. Instead of squares of glass similar pieces of iron may be used. The bits must be cut from one and the same piece of glass plate or iron bar. I prefer iron as the bits may be cut more easily from a bar one inch broad and $\frac{1}{4}$ inch thick. The bits being thus arranged in rows on the entire surface leaving a margin of about a quarter of an inch in width all round, and the surface warmed over a fire, the hollowed face of the mirror shall again be smeared with water as before and placed over the prepared surface of the marble tool and gently pressed till the several bits of glass or iron all come in contact with the concavity of the mirror.

* Instead of the marble slab, two well-seasoned circular teakwood boards, each $\frac{3}{4}$ inch thick and screwed to each other with their grain at right angles, may be used.

It will be seen that the whole surface of the tool will be a trifle larger in diameter than the surface of the mirror. The mirror should then be removed and the marble surface allowed to cool. When the marble tool has completely cooled down fine grinding should be begun.

The marble tool should now be placed with its prepared face up on the wooden bed on which the glass for the mirror was placed during the hollowing-out process. The mirror being now placed with its face *down* over the marble slab, the grinding process should be carried on with the finer grades of sand one after the other, beginning with the 5 second grade. After grinding with each grade the mirror surface should be cleaned with water from time to time, dried and examined. When it is found that the entire surface has assumed a uniform texture, the next grade should be begun. The face of the tool should be cleaned from time to time and before a new grade of sand is begun the tool should be scrupulously cleaned with a brush and plenty of water, so that not a single particle of sand of the previous grade may linger on the tool surface or side. In the last stages of fine grinding (with the 30 min. and 60 min. sand) great care should be taken to see that the abrading powder remains quite wet and does not dry up, as in that case there is danger of the fine surface of the mirror being scratched. Care must also be taken that during grinding with these two grades, the abrading powder is not mixed with too much water; in that case also there is danger of scratches by reason of the mirror surface coming in too close a contact with the tool. The abrading material should be kept sufficiently wet with a good supply of the powder; that is to say, the mixture of the powder with water should not be too thin.

During the entire fine grinding process there should be very little circular stroke used; the stroke should be straight and of one-third amplitude, that is, the mirror being held with the hand should be moved backwards and forwards, the edge of the mirror not passing more than one-third its diameter beyond the edge of the tool; while giving this straight stroke, the mirror should also be rotated with the hand very frequently and moved at the same time a very little to the right and also to the left, while the tool is turned with the left hand round and round from time to time always in one and the same direction, along with its wooden bed.

Throughout the grinding process, the operator may remain stationary and need not walk round and round as he would have to do if the tool or the mirror, whichever

is lower, were fixed on the table. Before the grinding of the surface with 5-second sand is begun, the circular margin of the surface should be bevelled with the same grade of sand about ⅛ inch in width by grinding the margin with the mirror face down over an iron concave tool; and this bevelling should be done with the next grade of sand before surface grinding is commenced with the same grade. This may be continued up to the 30-min. sand and no further. An ordinary concave country frying-pan sold in the bazars may serve as the bevelling tool.

Instead of the tools suggested above, a circular piece of glass plate of the same size and thickness as the intended mirror may be used as the grinding tool. The glass for the intended mirror should be ground over the glass for the tool throughout all the stages of the grinding process from the very beginning. The result of such grinding will be that of the two flat surfaces in contact, the upper one will become concave and the lower one convex. This concavity and convexity will increase with the duration of the grinding. This method of grinding may be adopted if preferred.*

This finishes my notes regarding grinding of specula. These notes are intended for mirrors from three inches to eight inches in diameter. I have said before that the focal length should be about nine times the diameter of the mirror. This would be the proper length for the bigger sized mirrors, say six to eight inches in diameter. For the smaller ones, I prefer making the focal length about fifty inches, for in that case greater magnification is obtained with the eye-pieces used.

The cementing material I use is resin powdered and melted with a quantity of mustard oil so as to give it the requisite consistency. In this way the resin may be made soft or hard as required. This material serves all purposes, including cementing as well as making the surface of the polisher. I prefer using resin specially to avoid the bad odour of pitch when melted.

I do not propose to say much about polishing and figuring. The object of the polishing process is to impart to the fine ground surface the lustre of glass. The abrading material used is ronge (an oxide of iron) mixed with water over a bed of pitch or resin. It is really a far more delicate stage of grinding, by which *perfect* evenness is imparted to the surface, which is thus made reflective.

The object of the figuring process is to impart to the polished concave surface the exact parabolic form which

*In this connection may I enquire of Mr. Buchanan if his zinc tool was grooved ?

alone would give a distinct image of a celestial object by bringing all its rays to a focus. For this purpose testing is best done from time to time with the well known shadow (or knife edge) test devised by the eminent French Physicist Lêon Foucault.

I should note here, that I always prefer polishing and figuring with the mirror face *down*, the polisher being placed below the mirror with its face up. In this case there is not much fear of scratching the mirror face; as any particle of grit which may insinuate itself between the mirror and the polisher is likely to settle down in the grooves of the polisher, while if the mirror is polished face up, the same particle may work havoc on the mirror face, and then the entire process of fine grinding may again have to be gone through from the beginning.

The last thing to be done is to deposit a very, very thin film of metallic silver on the finished mirror surface by a beautiful chemical process due to the great German Chemist Liebig.

The processes mentioned above are followed by Messrs. S. K. Dhar & Bros. of Hooghly, in the manufacture of their instruments, and the notes are mainly collected from what they have been led to adopt in their works.

All these processes are described in various articles published from time to time in *The English Mechanic*, *Amateur Work*, *Work*, &c. A little book entitled *Glass Working*, published by Cassell & Co., devotes a short but useful chapter to the subject. The whole subject is elaborately dealt with in Draper's paper on the construction of a 15½ inch mirror and Ritchey's paper on the modern reflecting telescope, which have both been recently published as separate volumes by the Smithsonian Institution of Washington, U. S. A.

Members interested in the subject will oblige the writer as well as other Members by giving additional information in the pages of the JOURNAL.

The View of the Mountains surrounding the Man Imbrium.

By N. L. Banerjee,

This evening we shall see what view our imaginary observer on the moon will obtain of the Apennine, Caucasus and Alpine mountains around the Man Imbrium.

The Apennine Mountains extend from the west of the fine ring plane Eratosthenes, on the south of the Man

to the extreme west enclosing practically the whole of its south-western corner. Its eastern range runs from Bradley to Huygens, being the loftiest portion of the mountains, whose height at places is nearly 20,000 feet over the bed of the Man, and whose average general elevation is about 10,000 feet. It then falls with a gentle slope towards Wolf at the south-east, assuming a height of about 6,000 feet. The western range of these mountains extends for 184 miles from north to south and 166 miles from east to west, unbroken by great valleys and with a very considerable general elevation. On its western extremity the mountains sink softly towards the Man Serenitates, broken by broad valleys and several extensive depressions. On its south-eastern end the mountains are somewhat steep and more connected, and the average height of the plateau is 6,500 feet.

Towards the north the Apennines culminate in the high peak Hadley and terminate at the lofty peak β. Between Hadley and Bradley, the northern border of the Apennines is formed by a great curved mass of cliffs and high peaks, from the foot of which numerous ridges and spurs project on to the plain and the surface gradually slopes down to the Palus Putredinis.

Beyond Mt. Hadley on the south is a large plane land which separates the Apennines from the Caucasus mountains and connects the Man Imbrium with the Man Serenitates. The Caucasus mountain is not very long, but comparatively broad, consisting of a lofty mass of high lands, bordered by great mountain peaks, as high as those on the Apennines. It is highest on the east, but much broken by valleys and ravines. The outlying peaks of Theaelus are 5,000 and 9,100 feet high, while the highest peak Calippus α is nearly 19,000 feet high. Towards the west the mountain is lower, but on the north-west it rises again attaining a height of 12,000 feet.

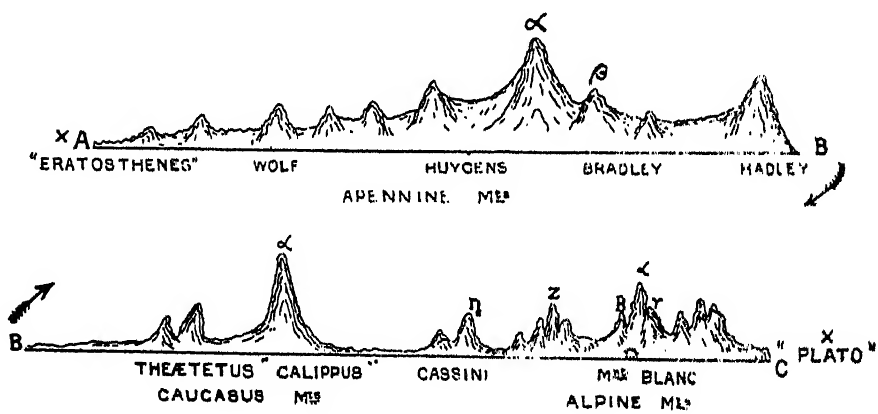
Between the Caucasus mountains and the extreme south-western end of the Alpine mountains is situated Cassini, a fine ring plane 36 miles in diameter, having walls 4,200 ft. above its outer surface, with two lofty peaks on the north 5,000 and 6,000 feet high.

The western Alpine mountains extend from the high peak Cassini η to the ring plane Plato, in a great curve forming a high crest to the steep towards the Man Imbrium of the lofty Alpine highlands. At Cassini η the Alps rise in a high peak 7,600 feet high with a projecting buttress terminating in a point 1,300 feet above the Man. From here, gradually increasing in height from 3,000 to 4,000 feet high, they extend to the massive mountain Cassini Z

possessing 3 lofty peaks, the highest being 8,500 feet above the Man. Next comes the great mountain Man termed Mont Blanc, whose southernmost peak r is 6,300 feet high, the chief peak α about 14,000 feet and east β 6,300 feet high. The western portion of the Alpine range ends at Mount Blanc δ, a peak somewhat detached from the rest and perhaps 8,000 feet high. West of the high crest of the Alps extend the great Alpine highlands with an average height of 6,000 feet, and with peaks perhaps surpassing even those of the great eastern border chain.

After the Mont Blanc the mountains gradually slope down to small valleys broken by detached projections, then rapidly rise towards the ring plane Plato. Here the Alpine highlands lose little in height or massiveness, the slope towards the Man Figoris becoming still steeper, though that towards the Man Imbrium becomes a long, gently sloping incline broken at places by peaks—the peak Plato η 12,000 feet high, ξ 8,500 feet, ω 8,700 feet. The easternmost part extends to the northern border of the ring plane Plato, where the height is only 3,000 ft.

Thus the whole range of the mountains surround the Man Imbrium in a semicircular form extending over nearly 900 miles in length. By spreading out the different ranges in a straight line, the mountains with their numerous peaks may be graphically represented thus :—



As the circumference of this semicircle is nearly 900 miles, the full view of the entire mountain cannot be obtained from any particular plan, considering the curvature of the moon-surface. Our imaginary observer must therefore walk along the foot of the mountains to have a complete view of the numerous peaks

Extracts from Publications.

At the meeting of the British Astronomical Association Dr. Crommelin said that there was a point in Mr. Holmes's paper on Meteors that lent itself to simple numerical testing; that was the suggestion that many Meteors entered our atmosphere and passed out again. He (the speaker) by blackboard diagrams proceeded to show that of the Meteors of any particular swarm entering the upper atmosphere of the Earth only 1 in 80 would pass out again. He did not think they could increase the ratio in any way whatever, and consequently it would be too small a fraction of any Meteor shower to make any appreciable difference in the behaviour of the average Meteor. He knew very little about Chemistry but he was aware that a large amount of hydrogen was found in most Meteors, and the great affinity of hydrogen for the oxygen of the atmosphere would, he should fancy, accelerate the process of combustion. In the case of a leaden bullet there was no particular affinity between the lead and the atmosphere. He spoke subject to correction, of course. With regard to the resistance of the air, it was admitted that the resistance varied as a high power of the velocity. He thought in some gunnery tables the resistance was taken as varying as the cube of the velocity, and so in the case of these high planetary speeds they got a huge ratio compared with the resistance they got in gunnery. Mr. Holmes pointed out that there were many misleading statements in the text books, and it would be well if the hint were taken and those things were corrected in the future. Still, he thought on the whole there was no doubt the existing theory of Meteors was pretty well correct. Visual examination of their behaviour and inspection of the photographic tracks of Meteors would show that. He had a photograph himself which showed a Meteor entering the upper atmosphere as an almost invisible line; then it rapidly got brighter and brighter, until at last it came to the point where the Meteor burst. He took it that the bursting was one of the things that dissipated the Meteors. The gas got so hot and expanded so much that the outer shell of the Meteor could not hold it, and there was a regular explosion like a shell bursting. The dust resulting from the explosion would be much more resisted by the air than a larger body would be. He took it that the bursting was one of the factors in preventing so many Meteors from reaching the surface of the Earth.

[*Journal of the British Astronomical Association.*

Mr. W. F. Denning in his paper on "Meteoric Shower in Sagitta" says :—

It seems to me that should the photography of Meteors continue to provide us with very slender results, it will become necessary to arrange simultaneous watches for Meteors on an extensive scale. When this is effected on more accurate lines than any previous attempts, it may be possible to suitably investigate various peculiarities of Shower Meteors, such as stationary and shifting radiants.

[*Journal of the British Astronomical Association*.

The Astronomical Society of India.—It is very gratifying to find that so many new societies have recently sprung into existence for the study of Astronomy. To all we wish success, but naturally the Astronomical Society of India appeals more particularly to us, being the only recent one of British formation. Some numbers of the JOURNAL are now before us, from which one may easily gather that the general arrangements of our own Association have commended themselves to the members. We are glad to notice that the President, Mr. H. G. Tomkins, F.R.A.S., is also the Director of the Lunar Section. It will be remembered that a few years ago he contributed to the British Astronomical Association (of which he is a member) several papers in connection with his theory as to the origin of the bright rays on the moon.

[*Journal of the British Astronomical Association*.

Future Policy in Astronomy—In his second address at the meeting of the Royal Astronomical Society, Sir David Gill gave his views on future procedure in two departments of Astronomy which in both cases had some relation to the subject for which the Gold Medal of the Society was awarded. In the first place, he thought that the time had come to limit the observations of the Moon. It is all but certain, Sir David said, that for such periods as a year the discordances between observations and Brown's Tables of the Moon will, apart from a small and practically constant difference for the year, be but a mere representation of the errors of observation, but the mean annual difference will vary slowly from year to year because of some of the long-period terms which remain unexplained by theory. Therefore Sir David suggests that continuous observations of the Moon at Greenwich, at least the extrameridian observations with the altazimulth, should be given up and that some observations during the year, at specially selected times, would be sufficient.

Further, he suggested that for detecting and determining the co-efficient of the long-period terms before mentioned, the observation of accultations of Stars by the Moon would be most valuable, so that future improvement of the lunar theory would be within the resources of the most modestly equipped observatory.

Secondly, the retiring President suggested that, besides doing its routine work for calculating the Almanac, the National Almanac office should be made into a department for the prosecution of Astrodynamics, that its staff should be increased by the appointment of some very able mathematician, who would aid Dr. Cowell in such work as computing the orbits of comets and planets and determining fundamental constants, or in any researches of a mathematical kind, the necessity for which may arise in Astronomy.

[*The Observatory.*

Curvature of Photographic Plates by Pneumatic Pressure.—The plates are, in their normal state, flat; they are flat when they are coated and sensitized, and they are flat when taken out of the telescope, but during exposure to the Stars they are bent by suction against a curved matrix. The enterprise has been successful, and as a consequence the field of good definition has been considerably extended.

Is this method of curving new? Curved plates have, of course, been tried before; it occurs to me to look up a reference to the success of Professor F. L. O. Wordsworth in 1901, and I see it noted that he managed to increase the available field of a double lens from 8° to 30°, and hoped to get even 45° ! (Unfortunately he is no longer at work in this direction). But I think his plates were permanently curved. So also were those we tried at Greenwich about 1886, with but indifferent success. The plates were inconvenient to store, and no doubt would have been more inconvenient to measure. The pneumatic plan avoids these disadvantages.

There will be some interesting work in determining the distortion of the field by the curvature, but I expect it will turn out to be a radial distortion varying as the cube of the radius. If we suppose for a moment that all radii remained unaltered in length, then the bending to the surface of sphere radius R would compress the circumference $2 r$ into the cicumference $2 \pi r$ R S in $r - R$ which differs approximately from the former value by a term

in r 3. But this supposition cannot fit the facts; there will no doubt be extention along the radius and compression perpendicular to it, and it seems not unlikely that both will vary as r 3. Hence we may expect to find on the released plate a radial distortion varying as r 3 which is apt to occur in any case (*see*, for instance, Mon. Not. LXXI p. 106) on plates with a large field. If the curvature introduces no essentially new disturbance it may be welcomed without reserve.

[*The Observatory.*

Water-vapour, carbonic-acid gas, ozone, and hydrocarbons, in the Earth's atmosphere prevent the rapid radiation of the Sun's heat into space. According to Dr. Arrhenius, the Earth's atmosphere contains about 0·03 per cent. by volume of carbonic-acid gas. If deprived of this, the surface-temperature would fall about 21°, and this would so diminish the amount of water-vapour in the atmosphere that another and almost equal fall of temperature would result. There is little doubt that the atmosphere of Mars contains a comparatively small percentage of water-vapour. That the heat received during the day is lost to a great extent during the night seems to be shewn by the aspect of certain parts of the planet's disc. Such regions as Hellas and Hesperia, in the south Temperate Zone, even in the summer season, are usually very white as they emerge from the night, often becoming dusky as they near the noon meridian, suggesting, as also do many other parts of the planet, the appearance of heavy frosts formed in the night and vanishing only under the noon Sun. Visual evidence thus seems to suggest that the mean temperature of Mars is much below that of the Earth; but the atmosphere of the planet surely possesses some quality which saves the possible Martians from such intense cold as one would expect to experience upon a world so situated.

A slight increase in the percentage of carbonic-acid gas in the Earth's atmosphere would tend to equalise the temperature between different portions of the Earth's surface. Thus, there would be less difference between the Torrid, Temperate and Frigid Zones. Dr. Arrhenius says that the oceans of the Earth, by absorbing carbonic-acid, act as regulators for the atmosphere. According to his figures, the oceans take up five-sixths of the carbon-dioxide artificially produced. Since Mars has no large bodies of water to act in this capacity, we would expect to find a greater percentage per volume of carbonic-

acid gas in its atmosphere than in that of the Earth if the sources of carbon dioxide are proportionately equal.

The Martian atmosphere exerts a pressure of less than 2 lb. to the square inch on the surface of the planet, and this is less dense by about one-half than the air on the tops of the Earth's highest mountains. Although so attenuated, the atmosphere of Mars is perceptible almost at once to the student of the Martian markings. The dark areas emerging from it near the western limb when the planet is near the Opposition, and therefore less gibbous, suggests the appearance of forests seen through a lifting fog. It is the atmosphere of Mars which causes the brilliant illumination all around the edge of the disc. A careful examination of the yellow regions has shown that they are usually slightly lighter near the centre of the disc, gradually darkening towards the planet's limb. Thus the atmosphere seems to absorb the light reflected from the brilliantly illumined deserts, just as a vast stretch of white sand on a beach becomes dusky in the distance. A point is reached near the planet's limb where the light reflected from the atmosphere is brighter than that reflected from the surface below it; hence the brilliant illumination of the extreme edge of the disc.

[*English Mechanic.*

The liquid generally used for cleaning object glasses is pure alcohol, which is applied with a pellet of soft wool. Of course, the glass must not be rubbed hard, and if a not superabundant quantity of the liquid is used, it will not require much drying. A soft camel-hair brush may be applied afterwards to remove threads left by the wool, or such things. The dewing of the object glass is a difficulty which cannot be overcome without much trouble. In a note in the Monthly Notices of May 1910, Mr. Franklin Adams wrote that he could have completed his series of photographs in two years, instead of six, if it had not been for the difficulty of keeping the lens surfaces free from dew; but he had searched and inquired for a satisfactory remedy without any result. Finally, he had devised a dew-cap made of two tubes, and into the space between he forced air chemically treated, which escaped through holes on to the surface of the upper lens. This plan proved effective; but as this would probably be unsuitable for a telescope of the size of Mr. Hibbert's, I do not give more precise details. The suggestion has been made at Greenwich that if a resistance wire were wound round the dew-cap and an electric current passed through it, sufficient heat might be generated to

prevent the deposition of dew, but the plan has not been tried.

[*English Mechanic.*

Major E. H. Hills, Secretary of the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society, has received from Father Cortie, of Stonyhurst College, the head of the Government Eclipse Expedition sent out to Vavan in the Southern Pacific, to observe the total Solar Eclipse of April 28th, a cable message to the following effect:—"Thick cirrus clouds at totality, but obtained some photographs of Corona and Spectrum. Corona of type characteristic of minimum sunspot period." Mr. F. W. Dyson, the Astronomer Royal, has received the following telegram from Mr. Worthington, an English Astronomer who went out to Vavan to observe the eclipse :—"Splendid photos inner and outer Corona, one and half degrees." Mr. Clement L. Wragge witnessed the eclipse from Lifuka, Friendly Islands, where he telegraphs : "The weather was cloudless. The hydrogen flames were wonderfully distinct, and four great Coronæ were observed, extending as far as 40,000 miles from the surface of the Sun."

[*English Mechanic.*

Memoranda for Observers.

Standard Time of India is adopted in these Memoranda.

For the month of July 1911.

Sidereal time at 8 p.m.

	H.	M.	S.
July 1st	14	34	6
,, *8th*	15	1	42
,, *15th*	15	29	18
,, *22nd*	15	56	54
,, *29th*	16	24	29

From this table the Constellations visible during the evenings of July can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

	H.	M.
July 3rd First Quarter ...	2	50 p.m.
,, *11th* Full Moon ...	6	23 p.m.
,, *19th* Last Quarter ...	11	1 a.m.
,, *26th* New Moon ...	1	42 a.m,

Eclipse.

An eclipse of the sun, visible at Calcutta as a partial eclipse, will occur on the 22nd October 1911.

The following are the Indian standard times of its different phases.

Begins, October 22nd, at ... 7-1 a.m.
Greatest phase, October 22nd, at 8-15 a.m.
Ends October 22nd, at ,, ... 9-38 a.m.

Magnitude (Sun's diameter = 1) = ·643.

Angle, from vertex, of first contact is 31° towards east.
Do. do. do. of last contact is 150° towards east.

Planets.

Venus.—Is an evening star. Its position on the 15th July at 8 p.m. will be R. A. 10 h. 35 m. 52 s. Dec. 9°-1′-2″ N. The time of its setting will be 9 h. 0 m. p.m. on the 15th July.

Saturn.—The position of this planet on the 15th July at 8 p.m. will be R. A. 3 h. 5 m. 24 s. Dec. 15°-5′-23″ N. The time of its rising will be 0 h. 43 m. a.m. on the 16th July.

Mars.—The position of this planet on the 15th July at 8 p.m. will be R. A. 1 h. 54 m. 31 s. Dec. 9°-27′-29″ N. The time of its rising will be 11 h. 43 m. p.m. on the 15th July.

Jupiter.—The position of this planet on the 15th July at 8 p.m will be R. A. 14 h. 12 m. 3 s. Dec. 12°-6′-12″ S. The time of its setting will be midnight on the 15th July.

Notices of the Society.

Election of Members.

The attention of members is invited to Bye-law No. 14, regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherji.

The Library.

An opportunity will occur during the next few months, owing to one of the members of the Society going to England, of obtaining books cheaply there for the Library. A subscription list has already been opened, and several members in Calcutta have subscribed and enabled the Council to make a beginning with the Library. Other members outside Calcutta, however, have not yet come forward, and as the Library will be one of the most important adjuncts of the Society, and will be available to members both in and out of Calcutta, those who have not done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

A number of books have already been received and can be borrowed by members in accordance with the Bye-laws.

The books available can be ascertained from the Assistant Librarian and a catalogue will issue shortly. The reading room of the Society in the Imperial Secretariat is now opened for the use of members daily from 5 to 7 p.m. except on Wednesdays and holidays, and from 3 to 5 p.m. on Saturdays, unless that day is a holiday.

Instruments.

The President will be in England for a short time this summer. He will be happy to assist any members who desire to purchase second-hand instruments by inspecting the instruments for them if they will communicate with the Director of Instruments *at once.*

Papers for Meetings.

It is requested that drawings which accompany papers for reproduction in the JOURNAL may be made with Indian ink on white paper. This will insure a clear reproduction.

Meeting.

The ordinary meeting of the Society will be held on the following date :—

June 27th, 1911.

The meeting will commence at 5 p.m. and will be held in the Imperial Secretariat (Treasury) Buildings. This will be the last meeting of the present session. The next session of the Society will commence on 1st October 1911.

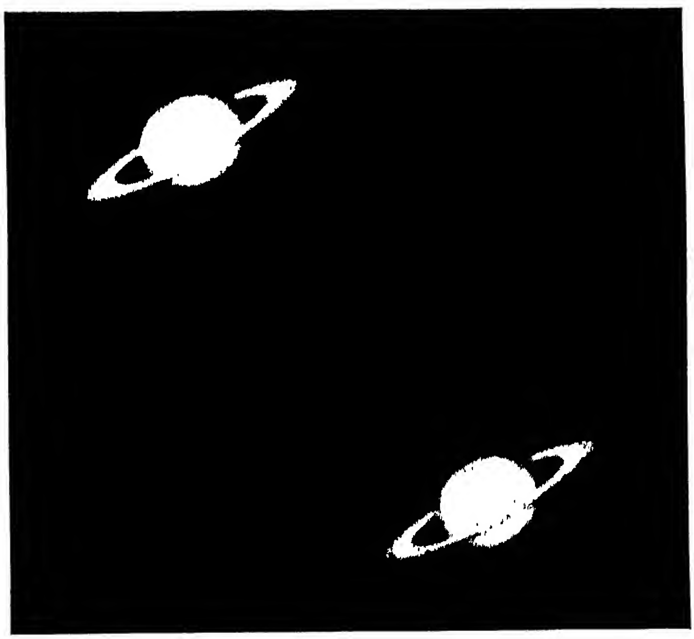


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911.

PHOTOGRAPH OF SATURN.

Taken at the Flag Staff Observatory by Dr. Percival Lowell,
on November 4th 1909.

Exposure 18 seconds.

Addresses of Officers.

(1) *President* . . .	H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.
(2) *Secretary (Scientific)* .	W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.
(3) *Do. (Business)* .	P. N. MUKHERJI, M.A., F.S.S. Imperial Secretariat Buildings, Calcutta.
(4) *Treasurer* . . .	U. L. BANERJEE, M.A., Office of the Acctt. General, Koila Ghat Street, Calcutta.
(5) *Librarian* . . .	ASHUTOSH MITTRA, M.A., 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.
(6) *Editor* . . .	CHAS. T. LETTON, 8. Hastings Street, Calcutta.
(7) *Directors:—*	
General Section . .	DR. E. P. HARRISON, Ph.D. Presidency College, Calcutta.
Lunar Section . .	H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.
Meteor Section . .	B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.
Variable Star Section .	LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., Dehra Dun.
Photography . .	R. J. WATSON, 37, Park Road, Barrackpore
Instruments . .	S. WOODHOUSE, 15, Wood Street, Calcutta.

The Journal of the

Astronomical Society of India.

VOL. I.] SESSION 1910-1911. [No. 9.

Report of the Meeting of the Society held on Tuesday the 27th June 1911.

H. G. TOMKINS, F.R.A.S., *President*, in the Chair.

The usual Monthly Meeting of the Astronomical Society of India was held in the Imperial Secretariat Buildings (ground floor) on Tuesday the 27th June, 1911, this being the last monthly meeting of the present Sessions.

The proceedings were opened by the President, and Mr. U. L. Banerjee read the minutes of the previous meeting, which were duly confirmed.

The President then announced the various presents given to the Society in the shape of astronomical journals and other papers, and the thanks of the Society were accorded to the donors.

The election of the following members by the Council was then confirmed :—

1. MR. SAMUEL N. ELIA TAINBY.
2. MR. C. R. RAMASWAMI.

The President then mentioned the names of Mr. W. Leatham, I.C.S., and Mr. Haran Chandra Banerjee, who had been elected by the Council as Auditors, to audit the accounts of the Society after 30th September, 1911, and submit their report before 31st October, 1911, which was confirmed.

The President next read out the names of the members of the Council proposed by the Council for the Session 1911-1912, mentioning separately the names of the Directors of

Sections, the Treasurer, the Editor and the Librarian proposed for appointment by the Council, as well as those of the President, the Vice-Presidents, the Secretaries and other 10 members, who are to be elected by ballot at the next Annual General Meeting. He also suggested that a few additional names might be proposed by the members and intimated to the secretary. Mr. U. L. Banerjee proposed the name of Mr. S. C. Mitra, M.A.

In mentioning the names of the Directors of Sections the President explained that it is proposed to abolish the posts of the Director of the General Section and the Director of Photography, and combine them with the Scientific Secretary, as their functions are identical.

The first paper of the evening was a note read by Mr. Rakshit on the August Meteors, his remarks being fully illustrated by lantern slides.

The President.—The shower is during the month of August. Have you got the date of the shower ?

Mr. Rakshit.—Yes, as I explained it will be about the 10th to 12th of August.

A vote of thanks was duly returned to Mr. Rakshit for his interesting note.

The next paper of the evening was one contributed jointly by Mr. Rakshit and Mr. A. T. Mitra on the Solar Eclipse of October, 1911, and was read by Mr. Ramaswani ; lantern slide pictures fully illustrating and explaining the notes were exhibited.

The President.—The eclipse will be rather a fine sight in Calcutta, and it is a form of amusement that any amateur might take up to observe this eclipse. There are several points to be observed. One of the most interesting features of an eclipse of the sun is to see whether the edge of the shadow is fairly smooth or not on the moon. The mountains stand out on the edge of the shadow and one gets some sort of an idea of what they will look like seen in profile. Of course the mountains in these circumstances are never seen like the mountains on the disc. Another interesting feature of a solar eclipse is the image of the partially eclipsed disc which is projected through the small apertures between the leaves of a tree. The whole question will be familiar to those who have ever practised pin-hole photography. Photographs have been obtained of these crescent shaped patches of light on a white ground during an eclipse. It is interesting and the result is very pretty. Those are the two main things, and then of course there are the timings of the eclipse and the size and position of the shadow, which, as you see in the

diagram, changes as the eclipse proceeds. It would be an interesting thing to draw a sketch fully representing the path of the shadow during the eclipse. Anybody who has a telescope can do it by projecting the image of the sun on a white screen. I hope we shall have a number of observations taken and sent in by members towards the end of October. The paper which has just been read gives the practical timings between 7 and 9-30 a.m., but people who are at the place can check the results. These two gentlemen have practically worked out the thing to the nearest minute, and have also been at some pains to make the slides, etc.

A hearty vote of thanks was accorded to Mr. Rakshit and Mr. A. T. Mitra for the pains and trouble they had taken over the paper, and a vote of thanks was also returned to Mr. Ramaswami for reading it.

Dr. Harrison then showed and explained some photographs of the sun received from Mr. Evershed, Director of the Kodaikanal Observatory, and read a note on the same. He explained his remarks by diagrams on the blackboard. There is cool hydrogen up above at the top of the larger prominences, the lower portions send light through the cooler top layers, and hence the light is absorbed and we see the dark outline of the prominence.

Take for example a spirit lamp flame with a little common salt put in it. The flame will give a yellow light due to the presence of sodium. Now suppose that we place near the flame some cooler vapour of sodium, the same vapour that was present in the flame. A series of waves will emerge from the lamp. The colder sodium vapour absorbs these waves and corresponds to the top of the prominence. No waves in this case pass through the cold sodium vapour. They are completely absorbed. That being the case, the effect will be darkness, and you will see nothing if you look at the hot sodium flame through the cooler layer of vapour. In the case of the prominences the ray of light passes through the cooler vapour of the same substance which exists at the top of the prominence and gets wiped out. This is the general outline of the explanation of the black streaks.

The President.—There is one point on which I should like to ask a question. In some of those photographs which have been taken, in the centre there appear bright prominences and in others dark ones. Is there any reason for this?

Dr. Harrison.—The only thing I can think of is that only in the case of the higher prominences do we get this absorption effect.

The President.—It may interest members to know that Dr. Michie Smith, if not the first, was one of the very earliest of astronomers to get photographs of the prominences in this way. I recollect that in 1907 he showed some slides in England at the Royal Astronomical Society there.

A hearty vote of thanks was accorded to Mr. Evershed for the photographs, and a vote of thanks was duly returned to Dr. Harrison for so ably illustrating and explaining his remarks regarding the pictures.

The President.—We have something of a sensation now in the shape of some pieces of a meteorite sent in by H. H. the Maharaj Rana Bahadur, Sir Bhowani Singh. I am sorry I have forgotten the letter, but will leave Mr. Rakshit to read the message and Dr. Harrison to explain and remark on this find.

Dr. Harrison.—It appears that the Society has got hold of a jewel in the pieces of this meteorite. I went down to the Survey of India and showed the pieces to Mr. Tipper and Dr. Christie. They announced it to be meteoric matter of the carbonaceous type and exceedingly rare and valuable. It is certainly the only fall of this nature discovered in India. There are only 8 other falls known of this type and Mr. Tipper kindly gave me a list of them. [Read out list.] The South African specimens, which are in the possession of the Geological Survey of India, are a little bigger than these. The specimens here to-night resemble the 8th find more than any of the others. The probability is that the meteorite fragment is almost pure carbon. The question arose the other day whether it may contain some of the nickel iron alloy. These things do contain this alloy very often, and as the present specimen shows a metallic looking crust in some parts, it probably contains a little nickel or iron. It is pretty clear that a small portion of the fragments ought to be sacrificed for analysis. We weighed it and found its weight to be 3 grammes, and we made a rough estimate of its volume. There are three problems which have to be decided. How much are we prepared to sacrifice for analysis? Then the next question is how to ascertain its specific gravity. It must not be put in water or any liquid for fear of oxidation or other chemical action so one is somewhat handicapped in trying to find its specific gravity. It was thought it might be possible for an artist to make a clay model of it and get the specific gravity in that way. I next tried to make an estimate of the magnetic permeability of the thing by comparing it with a magnet of known moment. It is certain that there is a certain amount of iron or magnetic alloy in it, but only very little indeed. The

third question is as to what we are to do with it. I think that probably the Council will recommend that it be handed over to the Geological Survey for the Museum, where there is already a fine collection of meteorites.

The President.—I think the first thing we have to do is to have this analysis pushed through, and we also have to decide as to what we are going to do with it. Dr. Harrison suggests that we make it over to the Museum and have it labelled as a present from us. I think we may leave that for the Council to decide. In the meantime I think we had better have the analysis carried out.

A hearty vote of thanks was accorded to the Rana Bahadur, and a vote of thanks returned to the officers of the Geological Survey for their courtesy in giving information about this meteorite, also to Dr. Harrison, amid much applause. The meeting was then adjourned to the next Annual Meeting which takes place on October 31st.

The Solar Eclipse of October 1911 as it will be observed in India.

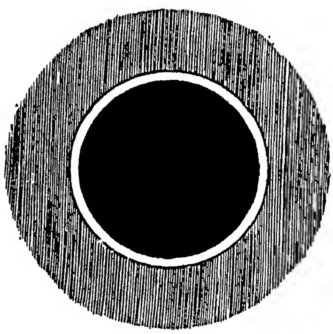
BY A. T. MITRA AND B. M. RAKSHIT.

We shall have an eclipse of the sun in the morning hours of the 22nd of October next. It will be visible from all parts of India, though the magnitude of the maximum phase will vary considerably. Thus for example the obscuration will be a quarter of the sun's diameter at Madras, a third of it at Bombay, two-thirds of it at Calcutta, three-quarters of it at Darjiling, and seven-eighths of it at Dibrugarh. In order to understand the cause of this difference we have to bear in mind that a solar eclipse is caused by the interposition of the moon between the observer and the sun. Just as an isolated patch of cloud sometimes cuts off the sun from view either wholly or in part, so the dark opaque moon sometimes comes between us and the sun, causing a complete or partial obscuration of his disc. Now, we have frequently noticed that a small patch of cloud does not conceal the sun from view equally for all; that while some are in the shadow others stand in sunshine. In the same way while the moon obscures the sun completely for some, for others it causes a partial obscuration, there being for some others no obscuration at all. Behaving, in an eclipse, like a patch of passing cloud the moon comes up to the sun, covers it and then moves away, presenting different views to different observers.

To have a more scientific idea of the subject we must conceive of two sets of common tangents joining the globes of the sun and the moon as in diagram No. 1. These form two cones of which one has its apex above the moon and the other has its apex below the moon The latter or the inverted cone contains the perfect or darker shadow known as the umbra and the former contains the lighter shadow known as the penumbra. These cones exist permanently in space, and when, owing to the relative positions of the sun, moon, and earth, they come in contact with our world we have an eclipse of the sun. This eclipse is partial or total according as the observer happens to be inside the penumbral or the umbral cone. When an observer happens to be at the surface of the external cone he sees only a simple contact of the discs of the sun and moon; when he is at the axis (*i.e.*, the line S.M. in the diagram) the eclipse is central for him; when he is between these two he finds the sun more or less obscured according to his nearness to the axis.

The rapid motion of the moon in the sky combined with the diurnal rotation of the earth makes the shadow cones sweep along the surface of our globe. As a locality is overtaken the eclipse commences at it. The obscuration grows there as the shadow passes on and the axis line comes nearer and nearer. It attains a maximum varying according to the approach of that line. Thus according to the position of a city or town an eclipse is central or partial. If the axis passes through it, it has a central eclipse, otherwise it has only a partial eclipse. A central eclipse again may be total or annular. When the umbral cone is long enough to reach the surface of our globe the central eclipse becomes total, but when the cone terminates up in the air at some distance above the ground, the eclipse becomes an annular one in which a ring of light is left uneclipsed, as shown in the illustrative figure before us.

The coming October eclipse will be an annular one, though in India it will be partial. The axis of the cone will trace out a line which will lie out of India. Starting from the Sea of Aral it will move south-east and pass through Turkestan, Kashgaria, Thibet and China. Then crossing the China Sea and passing between Borneo and the Philippine Islands it will enter New Guinea, passing out of which it will proceed along the sea for some time and then leave the earth. Places situated on this line will see the sun centrically covered by the dark disc of the moon with a ring of light surrounding it. The southern half of the penumbra will pass over India, making the eclipse visible from all parts of this country



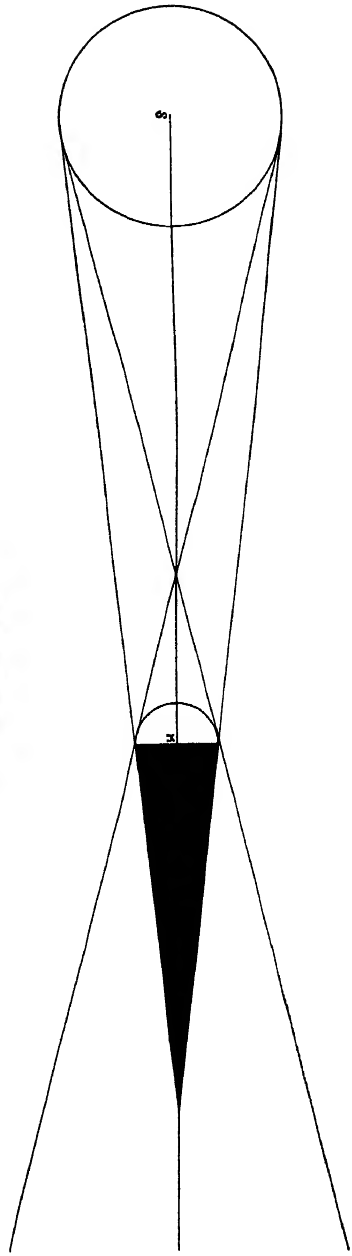


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911

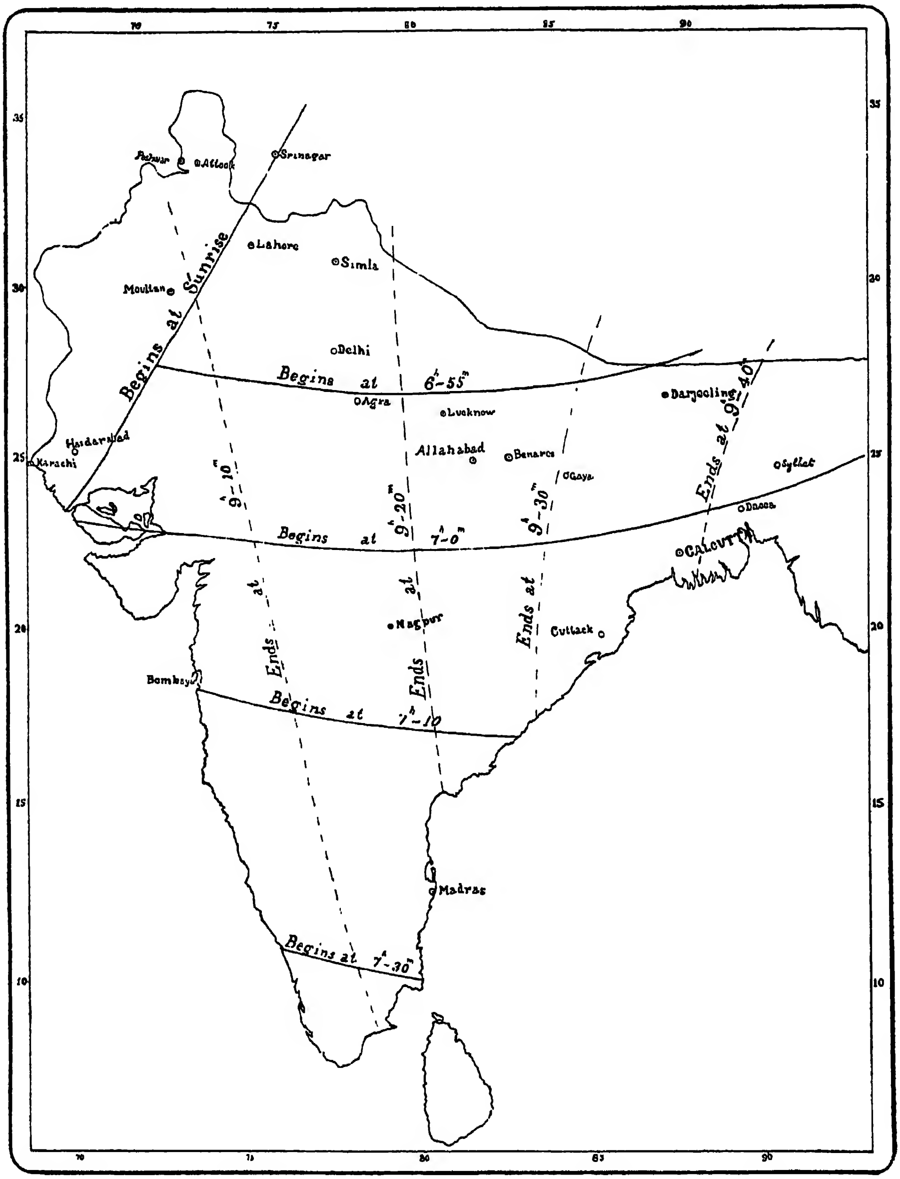


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1911

The phenomenon will be first visible at Srinagar in Kashmir (Fig. 2), where it will commence at sunrise, and the last station in India where it will continue after it has ceased to be visible elsewhere will be Dibrugarh, the easternmost city of Assam. The shadow cone moving south-east will enter India by its north-western extremity and gradually spread itself more and more over our country. As it moves on, its outline will stretch east and west and move southward. Now, all places lying on this outline at a particular instant will have the eclipse commencing simultaneously at that instant. Hence we shall have time lines joining the localities where the phenomenon will commence together. The map before us shows some of these lines, each of which indicates that at the standard hour marked near it, all the places north of it will be inside the penumbral cone and will therefore find the sun more or less eclipsed. Now, an examination of the time lines makes it clear that Kashmir and the Punjab will see the eclipse earlier than any other part of India. Next it will be visible in the North-Western Provinces and Rajputana. At the 7th hour of the morning it will become visible from almost all parts of upper India. Then gradually the time line will move down bringing the Deccan inside the penumbral cone. When the eclipse becomes visible at Cape Comorin, we must know that India is entirely inside the shadow, and that no part of our country is out of it. For over an hour it will remain completely within the penumbra, though the phase of the eclipse will continually change for every station while the simultaneous phases will be different for different stations. At last India will approach the boundary line of the shadow cone and commence emerging out of it. Sind and the Punjab will cease to see the sun eclipsed while the rest of India will still continue within the penumbra. We shall have now the outline of the cone stretching again across our country just as at the commencement of the eclipse. But the time lines at the end of the eclipse will move eastward and stretch north and south. Some of these are on the map before us. They indicate that at the hour for which a line has been drawn, all places west of it will find the sun uneclipsed while all stations east of it will find it still eclipsed. An inspection of the lines shows that following Sind and the Punjab, Rajputana will pass out of the shadow, and then the North-Western Provinces and the Deccan, and last of all Bengal and Assam will emerge out of the penumbra.

There may be a natural curiosity to know how big the size of the moon's penumbra is at the earth, and how fast it travels. Astronomical treatises inform us that the maxi-

mum breadth of the shadow is about 4,800 miles and its average velocity at places where it is perpendicular is about 2,070 miles. In the present case the breadth of the penumbra will be about 4,416 miles, and we can form a rough idea of its speed when we consider that its outline will move from Delhi to Calcutta in about 23 minutes. From Delhi to Calcutta is, as the crow flies, 815 miles. The velocity calculated from these data is a little over 35 miles per minute that is about 50 times the speed of the Punjab mail.

There is one point about the map before us which cannot be passed over. Stretching from the mouth of the Indus to Srinagar in Kashmir we notice a line at all points of which the eclipse will commence at sunrise. Places lying west of this line will have the sun rising more or less eclipsed, whereas all places east of this line will have the eclipse commencing after sunrise. As the line passes between Lahore and Multan the sun will rise eclipsed at Multan, while the eclipse will commence at Lahore ten minutes after sunrise. Karachi, Haidarabad, Quetta, Peshwar, Attock, and Rawal Pindi will see the sun rise more or less eclipsed.

Let us now pass on to the times and phases of the eclipse at some of the important stations of India. The annexed table gives the precise standard times of the beginning, middle and end of the phenomenon and the degree of obscuration at the maximum phase :—

	H. M. S.	H. M. S.	H. M. S.
Calcutta ...	7 1 28	8 15 17	9 38 36
Bombay ...	7 9 36	8 4 12	9 3 6
Madras ...	7 22 18	8 17 0	9 17 0
Lahore ...	6 51 34	7 57 45	9 11 47
Allahabad ...	6 57 3	8 6 8	9 23 50
Nagpur ...	7 3 33	8 6 54	9 18 0
Rangoon ...	8 13 1	9 33 17	11 3 15

We next proceed to consider in detail the times and phases of the eclipse at Calcutta. In this city the eclipse will commence at 7 hours 1·5 minutes standard time, or 7 hours 25 minutes local time. The point of the disc of the sun where the obscuration will commence will be 31 degrees to the left of the vertex as given in Figure 3. If we imagine the disc to be marked like a clock dial the point will be very near the mark XI, or more precisely, it will be where the end of the hour-hand is just two minutes before eleven o'clock. As time passes on the obscured portion will increase in size, and shift (to coin a term) anti-clock-wise, presenting the aspect shown in the diagrams before us at the standard times noted just above

each. The arrow represents the up and down line and the vertex of a figure is determined by imagining a line parallel to the arrow drawn through its centre. The fourth figure is the precise view of the maximum phase which will occur at 8 hours 15 minutes 17 seconds standard time. After this hour the obscuration will begin to decrease but continue shifting in the same direction as before. Seven and a half minutes after the view of the last figure (*i.e.*, at 9 hours 38 minutes 36 seconds standard time) the eclipse will end, the point of the last contact being 29 degrees left of the bottom, or where the hour-hand of a watch has its tip two minutes before seven o'clock.

The August Meteors.

BY THE DIRECTOR OF THE SECTION.

One of the most important meteoric showers is that of the Perseids of 10th to 12th August. It is a rich annual shower and its meteors are remarkable as rapid and leaving trails of luminous vapours behind them. As the meteors of this shower are not collected into a narrow path on each side of the computed orbit, but spread far on both sides of it, they are also visible some days before and after the above-mentioned dates. It is suggested that if the weather permits observations may be taken of the shower, and in order to facilitate the observations a short description of the constellation Perseus which contains the radiant point is now given. This constellation is situated north of the zodiacal constellations Aries and Taurus. Most persons, I suppose, know the star cluster known as the Pleiades in Taurus. North of this star cluster will be found in a curved line from south towards north the three stars s, ϵ, and v Persei. Of these the lowest and the middle one are of the 3rd and the uppermost of the 4th magnitude. North of v Persei will be found, in a line running from south-east to north-west, the four stars δ, α, y, and η Persei; their magnitudes are respectively 3·2, 1·9, 3·1, 3·9. On the south and a little towards west of α is the remarkable variable star named Algol or β Persei. On the 10th of August α Persei will rise at Calcutta at 10h. 5m. p.m., and its amplitude or the angular distance from the east point will be 55° 30′ towards north. The R. A. and the declination of the radiant point of the shower are respectively 3 hours and 57° N. On the 10th of August it rises at Calcutta at 9h. 5m. p.m., and its amplitude will be 65° 18′ towards north. It is very near the small star η Persei.

Pieces of a Meteorite.

PRESENTED BY H. H. THE MAHARAJA RANA BAHADUR OF JALAWAR.

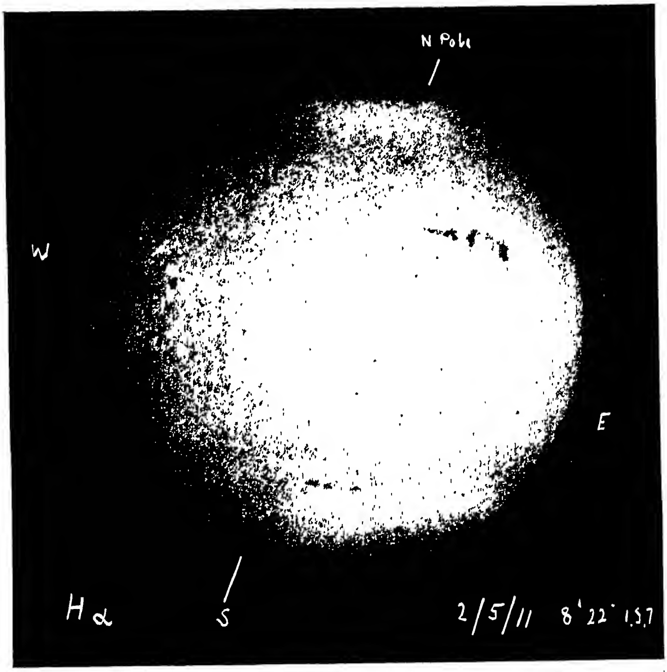
A brilliant meteor was seen by H. H. the Maharaja Rana of Jalawar on the 22nd January, 1911, at about 4 p.m., and reported to the Society. The account appears in JOURNAL Vol. I No. 4 page 94. His Highness heard lately that the meteor had burst and fallen in a shower of stones. He obtained three specimens which he has sent to the Society. They appear to be unique specimens as far as India is concerned, and the following note on them by Dr. Harrison is of great interest.

The following is an extract from a letter received by the President from His Highness the Maharaja of Jalawar :—

"A brief note regarding the meteor which was seen here (Jhalrapatan) at 3·55 p.m. on the 22nd January last has already appeared in the JOURNAL of the Astronomical Society. The following facts apparently relate to the same meteor: A few weeks ago His Highness the Nawab Sahib of Tonk visited my capital, and in the course of conversation one of his officials told me that on the 22nd of January last a very loud report was heard at Chabra at about 4 in the afternoon, and was followed by a shower of small pieces of black stone. At my request a few of these pieces were sent to me, for which my thanks are due to His Highness the Nawab Sahib. Some of these pieces I now send to the Director Meteorite Section."

The fragments were examined by Mr. Tipper and Dr. Christie of the Geological Survey of India. They feel convinced that the meteorite is of the rare carbonaceous type, consisting probably of almost pure carbon. There appears to be a metallic crust in certain places which may be due to the presence of the magnetic alloy of iron and nickel, and in one or two spots there appear to be very small pieces of meteoric stone. The fragments of meteorite are probably very valuable, as only eight other meteorites of the same type are known to have fallen, and the present specimen is the only carbonaceous meteorite ever recorded in India. Mr. Tipper kindly gave a list of the other recognised falls of this type. They are as follows :—

Photographs of the sun taken at the Kodaikanal Observatory,
and kindly communicated to the Society
by the Director.



The solar disc photographed in the H $_{\lambda}$ line on 2nd May 1911
h. m.
8-22 1st and under number 8.

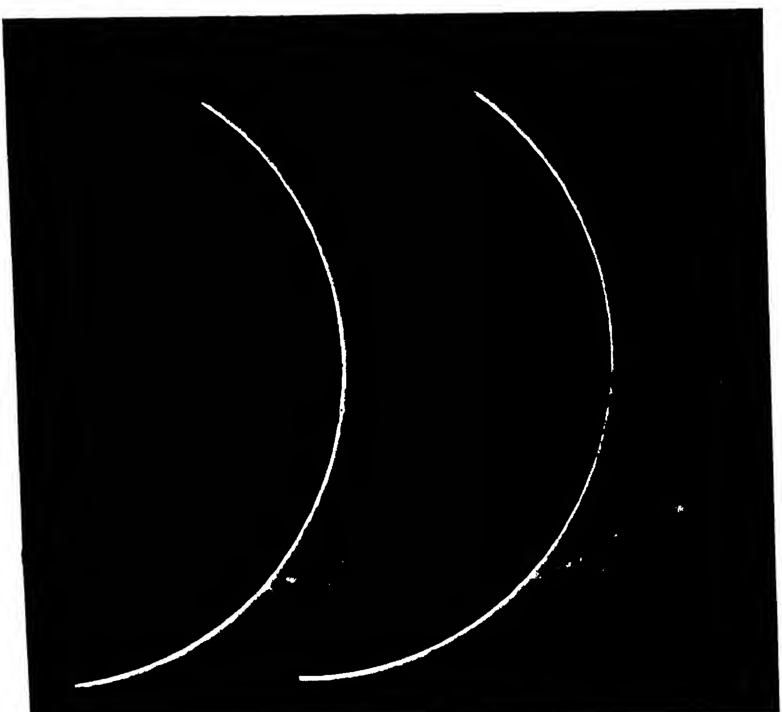


Photo.-Engraved & printed at the Offices of the S. of I., Calcutta, 1911.

h. m. h. m.
Solar Prominences taken in the K line at 10-9 and 10-12 on the

(*i*) Alais in France.
(*ii*) Colddel Bokkenveldt, South Africa.
(*iii*) Grazac, France.
(*iv*) Qudarch, Caucasia, Russia.
(*v*) Kaba, Hungary.
(*vi*) Mighie, Russia.
(*vii*) Nagaya, Argentine.
(*viii*) Orgeuil, France.

Solar Prominences.

By Dr. E. P. Harrison.

After describing the photographs of the Sun sent from Kodaikanal, Dr. Harrison said :—

The phenomenon of absorption of light which is responsible for the appearance of the dark prominences may be illustrated by analogy in some such way as this. Suppose a bridge of boats stretched across a river. Suppose also a series of waves to be travelling down the river towards the bridge of boats. Those boats whose natural vibration period corresponds to any particular set of waves among the advancing group, will be set into more violent oscillation than their neighbours by the passage of the waves. Only those waves which have a period nearly equal to a boat's period will affect the oscillation in this way. Waves of lengths other than the particular length suitable to the boats' own period will pass on past the bridge of boats. The set which *is* suitable, however, will give up their energy to the swaying boats, increasing the oscillations of the latter and themselves becoming wiped out. Let us apply this process by analogy to the light waves which come from the lower part of the hot prominences in the sun. A series of waves of the same type emerge from the neighbourhood of these heated gases; as these light waves pass outwards towards our telescopes, they, in many cases, encounter masses of somewhat cooler gas in the outer portions of the prominences. The light waves give up their energy to the atoms of this cooler gas of the same type and consequently become wiped out, and we perceive the outline of a *dark* prominence. This process is analogous to the behaviour of the water waves and the bridge of boats. The water waves represent the light waves from the hot base of the prominences, while the bridge of boats represents the atoms of somewhat cooler gas above, in the outer portion.

Memoranda for Observers.

For the months of August, September, October and November.

Standard Time of India is adopted in these Memoranda.

For the month of August 1911.

Sidereal time at 8 p.m.

		H.	M.	S.
August	*1st*	16	36	19
,,	*8th*	17	3	55
,,	*15th*	17	31	31
,,	*22nd*	17	59	7
,,	*29th*	18	26	43

From this table the constellations visible during the evenings of August can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

			H.	M.
August	*2nd*	First Quarter	4	59 a.m.
,,	*10th*	Full Moon	8	25 a.m.
,,	*17th*	Last Quarter	5	41 p.m.
,,	*24th*	New Moon	9	44 a.m.
,,	*31st*	First Quarter	9	51 p.m.

Meteors.

	R.A.	Dec.	Character.
July—September	335°	+73°	Swift, short.
July—August	339°	−27	Slow, long
July—August	280	+57	Slow, short.
* *August 10th* to *12th*	45°	+57	Swift, streaks.
,, *15th*	290	+53	Swift, bright.
,, *15th* to *25th*	291	+60	Slow, bright.
,, *25th*	5	+11	Slow, short.
August—October 2nd	346	0	Slow.
August—October 2nd	74	+42	Swift, streaks.

Planets.

Venus.—Is an evening star. The position of this planet on the 15th August at 8 p.m. will be R. A. 11 h. 44 m. 45 s. Dec. 3°-12′-34″ S. The time of its setting on the 15th August will be 7 h. 46 m. p.m.

* This shower is the noted one known as the Perseid Meteor Shower.

Saturn.—The position of the planet on the 15th August at 8 p.m. will be R. A. 3 h. 12 m. 33 s. Dec. 15°-27′-52″ N. The time of its rising will be 10 h. 48 m. p.m. on the 15th August.

Mars.—The position of the planet on the 15th August at 8 p.m. will be R. A 3 h. 9 m. 14 s. Dec. 15°-34′-46″ N. The time of its rising will be 10 h. 45 m. p.m. on the 15th August.

Jupiter.—The position of the planet on the 15th August at 8 p.m. will be R. A. 14 h. 21 m. 25 s. Dec. 13°-2′-14″ S. The time of its setting will be 10 h. 6 m. p.m. on the 15th August.

For the month of September 1911.

Sidereal time at 8. p m.

		H	M.	S.
September 1st	... ...	18	38	32
,, *8th*	... ...	19	6	8
,, *15th*	... ...	19	33	44
,, *22nd*	... ...	20	1	20
,, *29th*	... ...	20	28	56

From this table the constellations visible during the evenings of September can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

		H. M.
September 8th Full Moon	...	9 27 p.m
,, *15th* Last Quarter	...	11 21 p.m.
,, *22nd* New Moon	...	8 7 p.m.
,, *30th* First Quarter	...	4 38 p.m.

Meteors.

	R.A.	Dec.	Character.
July—September ...	335°	+73°	Swift, short.
September 3rd to 8th	353	+39	Very swift.
,, *5th to 15th*	62	+36	Swift, streaks.
,, *6th to 17th*	106	+52	Swift, streaks.
,, *15th* ...	77	+57	Swift, streaks.
,, *21st*	31	+19	Slow, trains.
,, *21st to 27th*	87	+43	Swift, streaks.
,, *27th* ...	4	+28	Slow, trains.
August—October 2nd ...	346	0	Slow.
August—October 2nd	74	+42	Swift, streaks.

Planets.

Venus.—Begins to be a morning star. It will be very close to the horizon at sunrise on 15th September.

Saturn.—The position of the planet on 15th September at 8 p.m. will be R. A. 3 h. 13 m. 17 s. Dec. 15°-23′-48″ N. The time of its rising will be 8 h. 46 m. p.m. on the 15th September.

Mars.—The position of the planet on 15th September at 8 p.m. will be R. A. 4 h. 9 m. 57 s. Dec. 19°-24′-25″ N. The time of its rising will be 9 h. 36 m. p.m. on 15th September.

Jupiter.—The position of the planet on 15th September at 8 p.m. will be R. A. 14 h. 39 m. 17 s. Dec. 14°-35′-10″ S. The time of its setting will be 8 h. 20 m. p.m. on the 15th September.

For the month of October 1911.

Sidereal time at 8. p m.

			H.	M.	S.
October	*1st*	... ..	20	36	49
,,	*8th*	... ...	21	4	25
,,	*15th*	... ...	21	32	1
,,	*22nd*	... ...	21	59	37
,,	*29th*	... ...	22	27	12

From this table the constellations visible during the evenings of October can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

				H.	M.
October	*8th*	Full Moon	... ...	9	41 a.m.
,,	*15th*	Last Quarter	... ...	5	16 a.m.
,,	*22nd*	New Moon	... ...	9	39 a.m.
,,	*30th*	First Quarter	... ...	0	12 p.m.

Meteors.

			R. A.	Dec.	Character.
October	*2nd*	...	230	+52	Slow, bright.
,,	*4th*	..	310	+79	Slowish.
,,	*8th*	..	77	+31	Swift, streaks.
,,	*8th* to *14th*	...	45	+58	Small, short.
,,	*14th*	...	133	+68	Rather swift.
,,	*15th*	...	31	+ 9	Slow.
,, *	*18th* to *20th*	...	92	+15	Swift, streaks.
,,	*23rd*	...	100	+13	Swift, streaks.
,,	*29th*	...	109	+23	Very swift.

*This is an important shower.

Planets.

Venus.—Is a morning star. The position of the planet on the 15th October at 8 p.m. will be R. A. 10 h. 58 m. 18 s. Dec. 2°·30′-2″ N. The time of its rising will be 2 h. 55 m. a m. on the 16th October.

Saturn.—The position of the planet on the 15th October at 8 p.m. will be R. A. 3 h. 7 m. 50 s. Dec. 14°-56′-54″ N. The time of its rising will be 6 h. 44 m. p.m. on the 15th October.

Mars.—The position of the planet on the 15th October at 8 p.m. will be R. A. 4 h. 37 m. 46 s. Dec. 21°-20′ 48″ N. The time of its rising will be 8 h. 2 m. p.m. on the 15th October.

Jupiter.—The position of the planet on the 15th October at 8 p.m. will be R. A. 15 h. 2 m. 13 s. Dec. 16°-21′-5″ S. The time of its setting will be 6 h. 41 m. p.m. on the 15th October.

Eclipse of the Sun.

An Annular Eclipse of the sun partially visible in India will occur on the morning of October 22nd. The line of the central eclipse passes from Turkestan through Thibet and South-East China into the China Sea. It then passes between the Philippine Islands and Borneo and through the southern part of the Island of New Guinea.

The times and extent of the eclipse for several places in India will be found in the paper on the subject in another part of the JOURNAL.

For the month of November 1911.

Sidereal time at 8 p.m.

				H.	M.	S.
November 1st	...	...	...	22	39	2
,, *8th*	...	..	...	23	6	38
,, *15th*	...	...	...	23	34	14
,, *22nd*	...	...	...	0	1	50
,, *29th*	...	...	...	0	29	26

From this table the constellations visible during the evenings of November can be ascertained by a reference to their position as given in the Star Chart.

Phases of the Moon.

			H.	M.
November	*6th* Full Moon	... ...	9	18 p.m.
,,	*13th* Last Quarter	... ...	0	50 p.m.
,,	*21st* New Moon	... ...	2	18 a.m.
,,	*29th* First Quarters	...	7	12 a.m.

Meteors.

		R.A.	Dec.	Character.
November	1st ...	43	+22	Slow, bright.
,,	2nd ...	58	+ 9	Slow, bright.
,,	5th to Decr. 4th	162	+58	Swift, streaks.
,,	10th—12th	133	+31	Very swift, streaks
,,	14th—16th	150	+22	Swift, streaks.
,,	16th—28th	154	+41	Swift, streaks.
,,	20th—23rd	63	+23	Slow, bright.
,,	17th—23rd	25	+43	Very slow, trains.
,,	25th to Decr. 12th	189	+73	Rather swift.
,,	30th	190	+58	Swift, streaks.

The showers on the 14th, 16th and 17th—23rd are the celebrated Leonid and Andromedid meteor showers respectively.

Planets.

Venus.—Is a morning star. Its position on the 15th November at 8 p.m. will be R. A. 12h. 22m. 49s. Dec. 1°-26′-16″ S. The time of its rising will be 2h. 25m. a.m. on 16th November.

Saturn.—The position of this planet on 15th November at 8 p.m. will be R.A. 2h. 58m. 21s. Dec. 14°-6′-40″ N. The time of its setting will be 5h. 25m. a.m. on 16th November.

Mars.—The position of this planet on 15th November at 8 p.m. will be R A. 4h. 13m. 18s. Dec. 21°-55′-46″ N. The time of its rising will be 5h. 35m. p.m. on 15th November.

Jupiter.—On the 16th of November this planet rises immediately after sunrise and sets immediately after sunset,

Eclipse of the Moon.

There will be a Penumbral Eclipse of the moon visible in India on the 6th November, 1911.

			H.	M.
First contact with Penumbra	...	...	7	9
Last ,, ,,	...	...	11	4

Extracts from Publications.

Speaking at the Meeting of the British Astronomical Association in April last, Major Grant said that Mr. Donald L. Springall had recently sent a number of communications with regard to the proposed calendar reform under the name of Mr. John C. Robertson. The proposal was to be discussed at a conference arranged by the Swiss Government at the instigation of the International Congress of Chambers of Commerce.

The proposal was that all four quarters of the year should each contain 91 days; that the week should be recognised as a definite unit of time, and that the months should contain four and five weeks. In the first quarter January was to contain four weeks, February four and March five, and that was continued through each of the quarters of the year. It was proposed that New Year's Day should be taken as a day separate from the calendar and called New Year's Day. The year would always begin on a Sunday and would, of course, end on a Saturday. Every month would begin on a Sunday and the whole calendar was arranged on a uniform principle. The advantages claimed for this calendar were that there would be only one set of monthly dates to memorise, and every fixed holiday would occur on the same day of the week, there would be fixed dates for Christmas and Easter; then all weekly markets would recur on the similar dates of each month, and quarter days would always recur on the same day of the week.

All months were even multiples of the week and began with the beginning and ended with the end of the week, and had therefore no troublesome fractions of a week to be dealt with.

Quarterly statistics with an equal quarter, of course, would be more easily compared, seeing that there was the same number of days, and the same would apply in the case of monthly and weekly statistics. It was claimed that the rotation of dates was not upset by reason of the first Monday, or Tuesday, or Wednesday, etc., of a month being preceded at times by later week days, and that all tabular work and books of account would be simplified and standardised. Then the regular recurrence of the extra week in the long months, instead of being a disadvantage, would possess peculiar advantages in giving the opportunity for special duties which it was not desirable to undertake so frequently as every month. Mr. Lynn's objections would be met inasmuch as it was suggested that the new calendar should start in 1916. Leap year was to be met by having a special day in the middle of the year, a special Bank Holiday at the end of the second quarter, and not taken into the calculation of the ordinary days of the year. He had a great deal of printed matter and correspondence about the proposed reform of the calendar, and as Mr. Lynn's paper had been read he thought it right to bring the matter up.

Captain Carpenter said he did not see how the matter affected the Association any more than it affected any other Association. They might have proposals that they should regulate their breakfasts and have poached eggs on Monday and boiled on Tuesday, kidneys on Wednesday, and so on.

Mr. E. Walker Maunder said that an alteration of the calendar would affect astronomers in some ways; as for instance when they were dealing with any historical question or with ancient observations of eclipses and the like. Personally when he had occasion to inquire into past astronomical events, he had always been glad when he got earlier than the Georgian reform of the calendar. The old Julian System was so straightforward and so easy to carry in the head, but when they had to allow for the dropping of ten or eleven days, as the case might be, they were very liable to be thrown out. So high an authority as Prof. Newcomb, perhaps the highest authority they had in their own time, expressed his doubt as to whether it was a wise thing to have adopted the Georgian Calendar, the advantage of the continuity of the Julian System outweighing any supposed advantage from the greater theoretical accuracy of the Georgian Calendar. The proposals now being made were open to the same objections in a much more aggravated form and were without any advantage to counterbalance

them. Some thirty years ago there was a congress held in Paris to discuss the reform of the calendar, and it struck him then as a significant thing that something like forty different plans were brought forward. He had been reminded of a little parable given by the late Prof. De Morgan in the introduction to his Budget of Paradoxes. He said it was quite conceivable that a fly might suppose itself as big as an elephant, and in that case it would be difficult to disabuse the fly of its opinion; but if they could put that fly amongst a thousand other flies, it might realise that it was no bigger than any of the rest. Each of the authors of these arrangements for reforming the calendar was confident that his own scheme was the ideal one, but when they saw forty others all equally confident about their plans, he thought that possibly Prof. De Morgan's little parable might have its application. Certainly 39 out of the 40 were mistaken; was it not probable that the 40th was just as far wrong?

[*Journal of the British Astronomical Association.*

The Rev. M. Davidson, investigating mathematically the heat and light of meteorites, summarises the results thus:—

Meteorites striking our atmosphere will have their surfaces fused, even at high altitudes, up to 100 miles, say, and if sufficiently large may become visible at that height owing to the heated air forming an envelope. The height at which they will have developed sufficient heat to cause complete volatilization will depend upon their size, velocity and angle at which they strike the vertical.

For large masses ranging from a few hundred-weights up to 30 tons, this amount of heat can only be generated when they have reached lower altitudes, from 23 to 45 miles according to velocity, size and angle with which they strike.

Small Meteorites like grains of sand or shot can develop this heat in the higher regions up to about 70 miles and might therefore be volatilized at this height.

For a height of 150 miles, if volatilization occurs there, the Meteorite is possibly in a gaseous state.

The resistance of the atmosphere to the motion of the bodies becomes greater as they diminish in size, and the temperature produced in them by friction against the air increases.

[*Journal of the British Astronomical Association.*

Naked-eye Visibility of Mercury.—Mercury was seen by the unaided eye on five occasions during his east elongation in April 1910, *i.e.*, April 24, 26, 28, 29 and May 6. This year the sky has been clearer, and I succeeded in obtaining observations on seven evenings as follows :—

		H.	M.	
April 7	... ...	8	10	very sparkling.
,, 11	... ...	7	45	,, ,,
,, 14	... ...	8	0	Steadier, pale primrose colour.
,, 15	... ...	8	0	Flashing *very* red.
,, 16	... ...	7	45	,, ,, ,,
,, 20	... ...	8	0	Faint ; pale primrose.

Venus was seen before sunset quite easily with the naked eye on March 1, 1911.

[*Miss Warner in the Journal of the British Astronomical Association.*

Halley's Comet.—This is still being diligently followed at the Yerkes Observatory. *Popular Astronomy* for May contains a reproduction of a photograph taken by Mr. F. Slocum with the 2 ft. reflector, with one hour's exposure. The comet appears quite distinctly as a short trail. It was then 110 million miles further from the Sun than on September 11, 1909, and yet very much brighter, showing that the physical brightening at perihelion persists for a long time. It will be followed at least up to conjunction with the sun, and possibly recovered in the autumn after that. Prof. Barnard writes that he got good measures on April 16, 23 and 25; an observation on May 2 was doubtful owing to moonlight. The comet was of mag. 15 in April but is rapidly getting fainter; its diameter is about 10″. On April 23 at 14h. 45m. 48s. G. M. T. its R. A. was 9h. 53m. 27·28s. S. Decl. 7° 48′ 23·9″. This was more than a year after perihelion passage.

[*Journal of the British Astronomical Association.*

Astronomy the Oldest Science.—Entering the first of the great buildings devoted to science (at the Coronation Exhibition) one comes at once to some very beautiful transparencies, chiefly of star clusters or nebulæ, which are the work of the big American observatories. These are followed by others for which Monsieur Deslandres is responsible, illustrating clouds of calcium and hydrogen in the upper atmosphere of the sun. Greenwich Observatory

is also represented, and there is a series of negatives of the moon taken for Mr. E. Ball Knobel (who organised the astronomical exhibits) at the Paris Observatory, as well as photographs of Halley's Comet and other photographs from the collection of the Royal Astronomical Society.

There is a collection of sundials and astrolabes; the oldest of the latter is one from Arabia belonging to Mr. Knobel, dated A.D. 1224. Another is one of the greatest treasures of Grouville and Caius College, as it was presented to it by the founder, John Caius, in the 16th Century, while a Chinese planisphere from the Royal Scottish Museum records observations which must have been made some thousands of years before the Christian era and handed down to the time of the maker. Two models sent by Greenwich Observatory are very remarkable. The first shows the orbit of Jupiter and the position of his moons up to the year 1911. The other illustrates a star cluster (in the constellation Taurus), and from it the position of the cluster with regard to our sun at any time during the last 800,000 years can be deduced.

[*English Mechanic*

In comparing refractors and reflectors the principal reasons of the preference for the latter amongst amateur astronomers in particular may, I think, be summed-up as follows:—Absolute achromation; the visual and actinic rays being brought to the same focus, this instrument is equally good for photography as for observing; the horizontal view of all objects looked at; and the price only a fraction of a refractor of the same size.

Prebendary Webb, the author of "Celestial Objects for Common Telescopes," whose qualifications to speak with authority on this subject no one will question, states in the above work:—

"An achromatic, notwithstanding the derivation of the name, will show colour under high powers where there is much contrast of light and darkness. Reflectors are delightfully exempt from this defect; and as now made with specula of silvered glass, well deserve from their comparative cheapness, combined with admirable defining power, to regain much of the preference which has of late years been accorded to achromatics."

In the *English Mechanic and World of Science* for June 20, 1879, W. S. Franks, the well-known observer, gives a very careful comparison between an achromatic

refractor and a reflector side by side, and concludes that the light of a 6½ inch silvered speculum is equivalent to that of a 5 inch object glass

[*Mr. G. Parry Jenkins in the Journal of the Royal Astronomical Society of Canada.*

Astronomical Society of India—In a letter to the Secretary asking that it be placed on our Exchange List the President of the above Society gives some interesting information regarding it. Though only founded on July 26, 1910, the Society has 250 members. Its meetings are held monthly at Calcutta, and the proceedings are printed in a monthly journal known as "The Journal of the Astronomical Society of India."

The Society is the first scientific body of its kind in India, and the speed with which members are joining shows that the country was ready for it. It has the highest official recognition, and a large number of Indian gentlemen are amongst its members.

The Royal Astronomical Society of Canada may well extend congratulations to a Sister Society in Greater Britain.

[*Journal of the Royal Astronomical Society of Canada.*

A remarkable meteor has been seen at Bristol. The sky was misty when the meteor ascended slowly from under the Polar Star, leaving a trail of sparks like a rocket. Crossing the zenith the meteor fell to the southward, and finally disappeared to the right of the planet Jupiter. The duration of the flight was 11 sec., and the whole path traversed was 118 deg. Mr. Denning of Bristol, who has been an habitual observer of meteors since the great shower of 1866, says that with one exception this meteor had the longest luminous flight of any which he has ever observed. It must, he says, have passed from above Shrewsbury to over the English Channel, near the island of Alderney, and its velocity was about 18 miles per second.

[*Daily Mail.*

The death is announced at Boston, Massachusetts, of Mrs. Williamina Paton Fleming, a well known lady astronomer.

Mrs. Fleming was born at Dundee, Scotland, in 1857, and became assistant in the Harvard College Observatory in 1879. At the time of her death she was in charge of the Astrophotographic Building, Harvard, where she had a staff of more than a dozen female computers under her. Mrs. Fleming discovered some new stars.

[*Daily Mail.*

Notices of the Society

Election of Members.

The attention of members is invited to Bye-law No. 14, regulating the election of persons who desire to join the Society. It is hoped that those who are already members will induce others to join. Forms of application can be had from the Secretary, Mr. P. N. Mukherji.

The Library.

An opportunity will occur during the next few months, owing to one of the members of the Society going to England, of obtaining books cheaply there for the Library. A subscription list has already been opened, and several members in Calcutta have subscribed and enabled the Council to make a beginning with the Library. Other members outside Calcutta, however, have not yet come forward, and as the Library will be one of the most important adjuncts of the Society, and will be available to members both in and out of Calcutta, those who have not done so are invited to help the Society in making a good start with this important branch of the work. Suggestions as to useful books for the Library will also be welcomed by the Librarian.

A number of books have already been received and can be borrowed by members in accordance with the Bye-laws.

The books available can be ascertained from the Assistant Librarian and a catalogue will be issued shortly. The reading room of the Society in the Imperial Secretariat is now opened for the use of members daily from 5 to 7 p.m. except on Wednesdays and holidays, and from 3 to 5 p.m. on Saturdays, unless that day is a holiday.

Subscriptions.

Some of the subscriptions are still due for the current session from members. Those who have not yet done so are requested to remit the amounts to the Treasurer.

The Treasurer will also be glad to receive those donations promised for the Library and quarters which have not already been paid, as the Council wish to take full advantage of the promised assistance as soon as possible during the present session.

Papers for Meetings.

It is requested that drawings which accompany papers for reproduction in the JOURNAL may be made with Indian ink on white paper. This will insure a clear reproduction.

Conclusion of the Session 1910-1911.

The present number is the last of the JOURNAL for the Session 1910-11, which will end on the 30th September 1911. The last meeting of the session was held on the 27th June, 1911, and in order to provide for the observations by Members during the recess, the Memoranda in this number have been carried up to November next. The office of the Society and the Library will remain open for business as usual, and the Directors will be glad to receive papers or other communications in order that they may make use of them in the next Session.

Annual General Meeting.

The second session of the Society will begin on the 1st October, 1911, and the Annual General Meeting will be held on Tuesday the 31st October, 1911, in the Imperial Secretariat (Treasury) Buildings at 5 p.m. The business to be transacted will be as follows :—

1. The admission of new members.
2. The presentation of the Annual Report of the Society.
3. The President's Address.
4. The announcement of the result of the election of the Council for the session 1911-12.

List of Members.

It is requested that members will check tiher names and addresses in the list which has recently been published and bring to the notice of Mr. Mukherji, the Secretary, any cases in which corrections are necessary.

List of Instruments.

With a view to enable the Council to obtain a knowledge of the instrumental equipment of the members, it is requested that those members who possess any instrument suitable for Astronomical work will kindly send details to Director of Instruments of its kind, size and power.

Meetings for the Session 1911-12.

Annual General Meeting October 31st.

ORDINARY MEETINGS.

1911	1912.	1912.
November 28th.	January 30th	April 30th
* December 26th	February 27th	May 28th
	March 26th	June 25th

* Subject to alteration under Bye Law 35.

The meetings will commence at 5 p.m. and, until further notice, will be held in the Imperial Secretariat (Treasury) Buildings.

Addresses of Officers.

(1) *President* . . .	H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.
(2) *Secretary (Scientific)* .	W. G. BURN, B.Sc., Assistant Controller of Stores, E. I. Ry., 105, Clive Street, Calcutta.
(3) *Do. (Business)* .	P. N. MUKHERJI, M.A., F.S.S. Imperial Secretariat Buildings, Calcutta.*
(4) *Treasurer* . . .	U. L. BANERJEE, M.A., Office of the Acctt. General, Koila Ghat Street, Calcutta.
(5) *Librarian* . . .	ASHUTOSH MITTRA, M.A., 6-10, Chowdhurie's Lane, Bagh Bazar, Calcutta.
(6) *Editor* . . .	CHAS. T. LETTON, 8. Hastings Street, Calcutta.
(7) *Directors*:—	
General Section . .	DR. E. P. HARRISON, Ph.D. Presidency College, Calcutta.
Lunar Section . .	H. G. TOMKINS, F.R.A.S., 9, Riverside, Barrackpore.
Meteor Section . .	B. M. RAKSHIT, B.A., 77-3, Musjid Barry Street, Calcutta.
Variable Star Section .	LT.-COL. LENOX CONYNGHAM, R.E., F.R.A.S., Dehra Dun.
Photography . .	R. J. WATSON, 37, Park Road, Barrackpore.
Instruments . .	S. WOODHOUSE, 15, Wood Street, Calcutta.

* Absent from station. All letters should be addressed to U. L. Banerjee, Esq. M.A.